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BOUNDARY LAYER DUST OCCURRENCE, I: ATMOSPHERIC DUST OVER THE WHITE SANDS MISSILE RANGE, NEW MEXICO AREA

B. D. Hinds, et al

Army Electronics Command
White Sands Missile Range, New Mexico

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ECOM-DR-75-2

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I: Atmospheric Dust over the White Sands Missile Range, New Mexico Area

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This report provides an overview of published and some previously unpublished data on atmospheric dust over the White Sands Missile Range, New Mexico area. The survey encompasses the occurrence of dusty conditions, the effect of the dust on the propagation of electromagnetic and acoustic energy, and per se properties of the dust. Data on the occurrence of blowing dust and dust storms at the White Sands and Holloman Weather Stations are tabularized. Published data on the propagation effect, refractive index, composition, number concentration and size distribution are summarized in an appendix by means of annotated references.

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Storm at White Sands, N.M.

The leaning edge of a wind-driven dune
spills. Over and over these pulverized

trickles of reality slide down the dune-face
like motions of white mindlessness, over and over.

Deep in the wide brown desert, this white
desert where wind blurs the light; the storm

is a force too great to be categorized.
Its friction charges the watcher with electricity.

He leans to earth to feel the spark click
from his finger. At the top of the dune

his outline whitens, like a film
overexposed, and he stands burning, consumed

by sand and storm, the force without category.
How quickly a spark enters the earth and is gone.

— Hayden Carruth

Esquire: February 1971

INTRODUCTION

During the past two decades various groups have conducted research relating to the particulate matter in the atmosphere over White Sands Missile Range (WSMR), New Mexico. Foremost among these efforts have been the searchlight experiments by the Air Force Cambridge Research Laboratories, the particulate sampling by the Johannes Gutenberg University (Mainz, West Germany), and the research conducted by the Atmospheric Sciences Laboratory.

By virtue of the wide dispersion of the published and unpublished results of these groups, it has become difficult for those interested in particulate matter over the WSMR area to establish an overview of extant knowledge concerning these particulates. With this in mind a survey to provide such an overview was prepared. This overview included: (1) tabularized data on the occurrence of dusty conditions, (2) annotated references to published data on properties of dust particles (composition, refractive index, size distribution, and number concentration) and on the effect of the dust on the propagation of electromagnetic and acoustic energy (extinction coefficients), and (3) the identification of data gaps.

It is the purpose of this report to not only survey the published data, but to assemble previously unpublished data on the probability of occurrence of dust conditions of various durations. Both journal articles and technical reports are included in the survey. It is recognized that publication overlap does exist where both mediums have been used to document essentially the same results. With the exception of the unpublished data, it is not within the purview of this report to provide a handbook of tabularized and graphical data, but merely to provide a framework for location of data of interest. It is incumbent upon the interested reader to ferret out any further detail he may require. Annotated references, arranged alphabetically by author, provide the key to the published data.

The main body of the report consists of tabularized data on the occurrence and frequency of occurrence of dust at the White Sands and Holloman Weather Stations. The summary serves to identify data gaps. Appendix A contains the listings of the individual occurrences of blowing dust and dust storms upon which the primary tables were based. Appendix B consists of a tabularized summary and annotated references to published work on atmospheric dust for the White Sands Missile Range area.

Part II in this series will present similar data for the Middle East, Near East, and North Africa; Part III will cover the U.S.S.R.

DEFINITIONS

Blowing dust is defined as dust raised by the wind to moderate heights above the ground which restricts horizontal visibility to less than 7 miles (11 km) [1].

A dust storm (including severe) is defined the same as blowing dust, except visibility is reduced to less than 5/8 mile (1 km) [1].

OCCURRENCE

Continuous 24-hour weather observations, which include records of the occurrence of blowing dust and dust storms and which date back at least a decade, are available from the White Sands Weather Station (WSWS) and from the Holloman Weather Station (HWS). The WSWS is located on the eastern slope of the Organ Mountains, which form part of the western edge of the Tularosa Basin of southcentral New Mexico. The HWS is situated 62 km northeast of the WSWS along the eastern edge of the Tularosa Basin.

As the basis for this report, the original weather records from both weather stations were examined. Data extracted from these records included the time of beginning and ending, duration in minutes, and the wind direction for each occurrence of blowing dust and dust storm. For the WSWS, the record examined spans the period from 1954 through 1973; for the HWS, 1960 through 1973. Data on the individual occurrences are contained in Appendix A.

These data are summarized in the following seven tables. Table 1 shows the total number of occurrences of blowing dust and dust storms for the period 1960-1973.

TABLE 1

TOTAL NUMBER OF OCCURRENCES OF BLOWING DUST AND DUST STORMS AT THE WHITE SANDS WEATHER STATION (WSWS) AND THE HOLLOMAN WEATHER STATION (HWS),

1960-1973

Site	Blowing Dust	Dust Storm
WSWS	180	14
HWS	418	82

[1]Federal Meteorological Handbook No. 1, Surface Observations, Change No. 2, 1 Jan 72.

Data on the diurnal variation of the frequency of occurrence of blowing dust by month for the WSWS for 1954 through 1973 are contained in Table 2. Data on the frequency of occurrence of various durations of blowing dust by month for WSWS for the same period are contained in Table 3.

For comparison purposes similar frequency of occurrence data for WSWS and HWS are presented in Tables 4 and 5 and Tables 6 and 7. Tables 2, 4 and 5 were based on the assumption that if the dust condition ended within 10 minutes prior to the hour or began within 10 minutes after the hour, then the dust occurred on that hour; these data are essentially a compacted form of similar previously published data (Appendix B, sections B-F, B-18, and B-19).

SUMMARY

The data on the occurrence of blowing dust (visibility < 11 km) and dust storms (visibility < 1 km) at the WSWS and HWS for the period 1960 - 1973 highlight the following points: (1) blowing dust occurs an average of 13 times per year at the WSWS and 30 times per year at the HWS (Table 1); (2) the highest frequency of occurrence of blowing dust at the WSWS is 4% and at the HWS 9%, both peaks occurring during late afternoon in April (Tables 3 and 4); (3) dust storms occur an average of once per year at the WSWS and six times per year at the HWS (Table 1); and (4) the frequency-of-occurrence patterns for various durations of blowing dust for the WSWS and the HWS are similar, with short durations predominating in summer and long durations predominating in spring (Tables 6 and 7). Although there is a difference in the frequency of occurrence of blowing dust and dust storms at the WSWS and HWS, these data may not even be representative of the extremes in dustiness to be encountered in the WSMR area, and caution should be exercised in applying these data either to other sites or to WSMR in general.

More extensive probing into these data is beyond the purview of this report. However, the data do merit further attention to ascertain environmental relationships, and it is hoped that the data presented herein will serve as a stimulus to such research.

ACKNOWLEDGMENTS

The authors wish to express their thanks to Marjorie Hoidale and Andrew Lewis for their assistance in compiling these data.

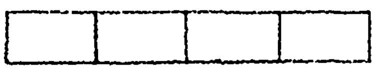
APPENDIX A

A chronological listing of each occurrence of blowing dust and dust storm for the White Sands Weather Station and the Holloman Weather Station is contained in Tables A-1 to A-4. With respect to these tables, several explanatory remarks are in order.

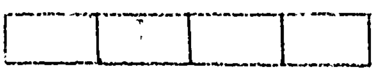
Column T

The column labeled T refers to the quarter of the day during which the bulk of the storm occurred (1 = 0000 to 0600 LST, 2 = 0600 to 1200, 3 = 1200 to 1800, and 4 = 1800 to 2400). Although the application of this scheme of temporal categorization is relatively straightforward, there are several cases which merit further explanation. Thus, for clarity and completeness, additional criteria for category selection are enumerated below:

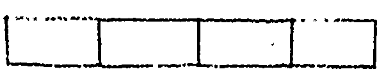
Single Occurrence

1. 

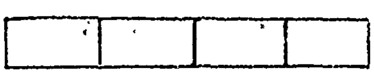
If blowing dust (or a dust storm) begins and ends within a given quarter, T simply carries the numerical code for that quarter.

2. 

If blowing dust starts in one quarter and ends in the following quarter, T will carry the code of that quarter having the greater duration of blowing dust.

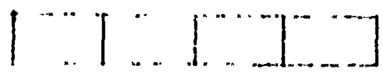
3. 

In the event that the blowing dust overlaps two time periods equally, the code refers to the first of the two periods.

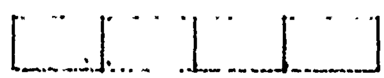
4. 

If the blowing dust is continuous over more than two periods, T refers to the first period completely dominated by blowing dust.

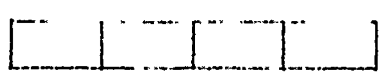
Multiple Occurrences

1. 

If the wind direction associated with successive occurrences (see Column DD below) changes by at least 90 degrees*, then two storms are identified, each carrying its own code.

2. 

If the wind direction associated with successive occurrences changes by less than 90 degrees and if the time separation is three hours or more, then two storms are identified, each carrying its own code.

3. 

If the wind direction associated with successive occurrences changes by less than 90° and if the time separation is less than three hours, then only one occurrence is recorded.

Column DD

This column refers to the direction of the wind at the onset of the blowing dust (or dust storm). The letter code represents the direction from which the wind is blowing. The symbol C indicates the wind was calm.

* Successive winds going from one wind direction to calm are considered representative of a change of less than 90 degrees, whereas successive winds going from calm to a given direction are considered representative of a change of 90 degrees or more.

TABLE 2

DIURNAL VARIATION OF THE FREQUENCY OF OCCURRENCE (%) OF BLOWING DUST BY MONTH
WHITE SANDS WEATHER STATION
(1954-1973)

HOUR	MONTH												AVG
(LST)	J	F	M	A	M	J	J	A	S	O	N	D	
00	*	*	*	1	*	1	*				*	*	*
01		1	*	1	*	1	*				*	*	*
02		*	*	1		1					*	*	*
03		*	*	1		*	*				*	*	*
04		1	*	1		*		*			*	*	*
05		1	*	1	*	1						*	*
06		1	*	1	*	1	*				*	*	*
07	*	1	*	1	*	1	*	*		*	*		*
08	*	1	1	1	1	1	*		*	*	*		*
09	*	1	1	1	1	1	*		*	*	*		*
10	1	1	1	1	1	1	*		*	*	*		1
11	*	1	1	2	*	1	*		*	*	*		1
12	1	2	2	2	1	1	*		*	*	1		1
13	1	2	3	3	1	1		*		*	1		1
14	1	3	3	3	2	1	*			*	1	*	1
15	1	3	4	4	1	1	*	*	*	1	1	*	2
16	1	3	4	4	2	1	1	*	*	1	1	*	2
17	1	3	4	5	2	1	*	*	*	*	1	*	1
18	*	4	4	4	2	1	*	*		*	*		1
19	1	3	3	2	2	1	1	*	*	*			1
20	*	2	2	2	*	1	1	*			*	*	1
21	*	1	1	1	*	1	*	*			*		*
22	*	1	1	1	*	1	*	*		*	*		*
23	*	1	1	1	1	1	*		*		*		*
AVG	*	1	2	2	1	1	*	*	*	*	*	*	1

* <0.5%, but ≠ 0

TABLE 3

FREQUENCY OF OCCURRENCE (%) OF SELECTED DURATIONS OF BLOWING DUST BY MONTH
WHITE SANDS WEATHER STATION
(1954-1973)

DURATION (hrs)	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
≤1	22	38	23	27	47	51	71	94	60	29	38	33
1-2	28	10	16	18	19	24	18	6	30	50	13	33
2-3	17	5	14	15	11	9	5			7	25	11
3-4	11	10	11	13	11	2	3		10		6	11
4-5	17	10	9	4		4	3			7	6	
5-6		8	5	4	2	2				7	6	11
6-7		5	5	6	4						6	
7-8		3	4	3	2	4						
8-9		3	5									
≥9	6	8	7	9	4	2						
Total %	101	101	99	99	99	98	100	100	100	100	100	99
No. of Obs.	18	40	56	67	47	45	38	17	10	14	16	9

TABLE 4

DIURNAL VARIATION OF THE FREQUENCY OF OCCURRENCE (%) OF BLOWING DUST BY MONTH
WHITE SANDS WEATHER STATION
(1960-1973)

HOUR	MONTH												AVG
(LST)	J	F	M	A	M	J	J	A	S	O	N	D	
00		1		*	1	*	*						*
01				*	*	*	*						*
02						*						*	*
03						*					*	*	*
04						*					*	*	*
05					*	*						*	*
06					*	*							*
07				*	*	*	*			*			*
08				*	*	*	*			*			*
09	*			*	*	*							*
10	*	*	*	1	*	*				*			*
11	*	*	1	1	*	*				*			*
12	*	2	2	1	1	*					*		1
13	*	2	2	3	1	*					*		1
14	1	3	2	3	1	*				*	*	*	1
15	1	3	2	4	1					*	1		1
16	*	3	3	4	2	*				*			1
17	*	2	2	4	2	1				*			1
18	*	1	2	4	2	1	*	*	*	*			1
19		1	1	1	2	*	1	*	*	*			1
20		1	*	1	1	1	*	*	*		*		1
21		1	*	*	1	1	*	*	*				*
22		1	*	*	1	*	*	*	*	*			*
23		1	*	*	1	*	*	*					*
AVG	*	1	1	1	1	*	*	*	*	*	*	*	*

* <0.5%, but ≠ 0

TABLE 5

DIURNAL VARIATION OF THE FREQUENCY OF OCCURRENCE (%) OF BLOWING DUST BY MONTH
HOLLOMAN WEATHER STATION
(1960-1973)

HOUR	MONTH												AVG
(LST)	J	F	M	A	M	J	J	A	S	O	N	D	
00	*	1	1	1	1	*	*				*	*	*
01	*	1	1	1							*	*	*
02	1	1	1	*	*					*			*
03	*	1	1	*					*	*	*		*
04	*	1	1	*				*		*			*
05	*	1	*		*		*	*		*			*
06	1	*	*		*		*						*
07	1			*	1		*		*			*	*
08	*	*	*	1	1		*		*	*		*	*
09	*	*	1	1	1					*	*		*
10	1	*	2	2	1				*		1		1
11	1	1	2	2	1				*		1	*	1
12	1	1	3	3	1				*		*	*	1
13	2	2	4	5	1		*	*	*	*	1	1	1
14	2	2	5	7	1	*		*		1	1	1	2
15	2	4	6	8	2	1	1	1		*	1	1	2
16	3	4	7	9	3	1	*	*		*	1	*	3
17	1	4	8	9	5	1	*	1	*	1	1	*	3
18	1	2	8	8	3	1	*	1	*	1	*	*	2
19	*	2	5	6	3	2	*	*	*	*		*	2
20	*	3	4	5	2	1	1	1	*	*			1
21	*	2	3	3	2	*	*	*	*	*	*		1
22	1	2	2	2	*	1	1		*	*	*	*	1
23	*	1	2	1	*	*	*	*			*	*	1
AVG	1	1	3	3	1	*	*	*	*	*	*	*	1

* <0.5%, but ≠ 0

TABLE 6

FREQUENCY OF OCCURRENCE (%) OF SELECTED DURATIONS OF BLOWING DUST BY MONTH
WHITE SANDS WEATHER STATION
(1960-1973)

DURATION	MONTH											
(hrs)	J	F	M	A	M	J	J	A	S	O	N	D
≤1	29	52	25	22	43	64	64	83		43	71	25
1-2	14	4	17	23	23	23	18	17	50	43		50
2-3	14	4	13	16	10		9			14	29	25
3-4	14	9	25	11	7		9		50			
4-5	29	13	8	5		5						
5-6		4	8	11	3	5						
6-7		9	4	5	3							
7-8				3		5						
8-9												
≥9		4		3	10							
Total %	100	99	100	99	99	102	100	100	100	100	100	100
No. of Obs.	7	23	24	37	30	22	11	6	2	7	7	4

TABLE 7

FREQUENCY OF OCCURRENCE (%) OF SELECTED DURATIONS OF BLOWING DUST BY MONTH
HOLLOMAN WEATHER STATION
(1960-1973)

DURATION (hrs)	MONTH J	F	M	A	M	J	J	A	S	O	N	D
≤1	38	24	24	23	42	73	82	74	88	50	40	38
1-2	14	20	21	21	19	17	11	26	13	38	20	46
2-3	21	15	10	10	14	10					27	
3-4	7	22	10	15	5		4			13		
4-5	3	2	4	7			4				7	8
5-6	7	7	6	12	5							8
6-7	3	5	6	1	5							
7-8	3	2	4	1	2							
8-9			4	1	5							
≥9	3	2	9	9	5						7	
Total %	99	99	98	100	102	100	101	100	101	101	101	100
No. of Obs.	29	41	67	82	43	41	28	27	16	16	15	13

TABLE A-1

WHITE SANDS WEATHER STATION
WHITE SANDS MISSILE RANGE, NEW MEXICO
PERIOD OF RECORD: 1954-1973

BLOWING DUST
(VISIBILITY < 11KM)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
126	1	1954	20	3	SW	121	6	1954	21	3	NE
243	2	1954	14	3	W	19	7	1954	7	3	E
66	2	1954	15	3	NW	139	7	1954	14	3	E
466	2	1954	18	4	NW	4	7	1954	16	3	S
690	2	1954	23	2	W	44	7	1954	17	4	S
1156	2	1954	24	2	C	31	7	1954	20	3	SE
870	2	1954	26	4	NW	118	7	1954	21	4	W
107	2	1954	27	2	NE	15	7	1954	28	3	SE
217	2	1954	27	3	NW	26	7	1954	28	4	N
134	3	1954	1	4	W	60	7	1954	31	3	SE
372	3	1954	3	3	SE	29	8	1954	1	4	NW
448	3	1954	8	2	W	8	8	1954	2	3	NE
64	3	1954	9	4	W	45	8	1954	6	1	SE
33	3	1954	10	3	W	12	8	1954	9	2	SE
100	3	1954	11	1	W	26	8	1954	18	4	S
703	3	1954	11	3	W	91	9	1954	9	3	E
31	3	1954	12	1	W	5	9	1954	10	3	N
76	3	1954	12	3	W	13	9	1954	12	4	W
454	3	1954	13	3	E	120	9	1954	21	2	SE
32	3	1954	14	1	NW	62	10	1954	24	3	SW
512	3	1954	15	3	C	4	10	1954	25	3	W
540	3	1954	17	4	S	122	11	1954	27	3	W
569	3	1954	23	4	W	345	11	1954	29	4	SW
464	3	1954	30	3	W	118	12	1954	4	3	W
15	4	1954	7	4	W	22	12	1954	16	1	W
463	4	1954	8	1	SE	218	12	1954	16	3	NE
1065	4	1954	16	2	E						
144	4	1954	21	3	W	31	1	1955	16	4	NW
23	4	1954	24	4	S	735	1	1955	31	4	W
388	5	1954	1	3	W	26	2	1955	3	1	S
143	5	1954	10	4	W	163	2	1955	9	4	W
12	5	1954	23	4	NW	524	2	1955	10	3	NE
30	5	1954	24	4	SE	209	2	1955	18	3	W
427	6	1954	3	2	SE	489	3	1955	16	3	SE
147	6	1954	5	3	W	15	3	1955	17	1	SW
234	6	1954	6	3	W	15	3	1955	18	2	NE
74	6	1954	12	4	SW	15	3	1955	19	3	NW
162	6	1954	18	4	SE	12	3	1955	20	2	W

TABLE A-1 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD
178	3	1955	20	4	SW
1587	3	1955	26	2	SE
125	3	1955	30	4	W
243	3	1955	31	2	NW
196	4	1955	2	2	C
878	4	1955	2	4	W
619	4	1955	3	3	NW
43	4	1955	7	3	S
725	4	1955	11	4	W
1321	4	1955	12	4	NW
421	4	1955	22	4	W
174	4	1955	23	1	NW
156	4	1955	28	4	SE
70	4	1955	29	2	S
15	4	1955	30	4	W
42	5	1955	2	3	NE
53	5	1955	18	3	NW
11	5	1955	21	4	W
200	5	1955	25	3	W
170	5	1955	29	2	S
34	6	1955	8	4	SE
686	6	1955	9	1	S
281	6	1955	10	1	S
15	6	1955	13	1	W
88	6	1955	21	4	SE
60	6	1955	22	4	E
73	6	1955	26	4	SW
169	6	1955	28	2	W
92	7	1955	4	4	NE
51	7	1955	7	4	NE
13	7	1955	14	3	E
32	7	1955	16	3	NE
66	7	1955	17	4	E
7	8	1955	5	3	NW
10	8	1955	10	3	E
25	8	1955	20	3	N
236	11	1955	7	3	NE
15	11	1955	15	3	W
382	11	1955	28	2	W
333	2	1956	2	1	S
314	2	1956	24	3	NW
712	3	1956	6	4	W
241	3	1956	12	2	SE
120	3	1956	28	3	E
22	4	1956	2	3	W
219	4	1956	24	2	SE
6	6	1956	7	3	SE
87	6	1956	15	3	NW

DUR(MIN)	MO	YEAR	DY	T	DD
28	6	1956	28	3	E
64	7	1956	26	2	SE
20	7	1956	27	3	SE
26	8	1956	24	3	E
15	10	1956	1	3	W
255	10	1956	24	3	W
356	10	1956	29	3	SW
246	11	1956	1	3	SW
160	11	1956	19	3	SW
75	11	1956	20	2	NW
32	1	1957	8	3	W
67	1	1957	10	2	SE
106	1	1957	21	3	W
150	1	1957	28	3	NW
127	3	1957	13	3	W
131	3	1957	22	3	W
217	4	1957	1	3	W
46	4	1957	18	3	SW
60	4	1957	22	1	W
71	4	1957	22	3	NW
190	5	1957	15	3	S
434	5	1957	20	3	W
246	7	1957	2	2	NW
27	7	1957	2	3	E
39	7	1957	5	1	SE
39	7	1957	5	3	E
54	7	1957	18	1	NW
6	7	1957	19	3	SE
22	7	1957	22	3	SE
26	8	1957	29	3	S
4	9	1957	9	3	NW
354	12	1957	11	1	S
74	1	1958	30	4	W
14	2	1958	11	3	N
61	2	1958	13	4	NW
47	2	1958	25	4	W
375	4	1958	2	3	W
161	4	1958	4	3	W
404	4	1958	7	3	SE
52	4	1958	8	3	W
55	4	1958	16	3	W
215	4	1958	23.	1	W
120	4	1958	23	4	W
3	5	1958	16	4	W
6	5	1958	29	3	NW
36	6	1958	2	4	S
26	6	1958	16	3	SE

TABLE A-1 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD
25	6	1958	25	3	SE
85	6	1958	26	4	S
15	7	1958	17	3	S
51	8	1958	3	4	NE
15	8	1958	24	4	SE
5	9	1958	3	3	S
5	9	1958	18	4	NE
45	12	1958	4	3	W
290	1	1959	2	3	W
120	1	1959	19	4	W
217	1	1959	20	2	W
330	3	1959	19	3	W
75	3	1959	24	3	W
288	3	1959	31	3	NW
66	4	1959	3	2	SE
35	5	1959	14	4	SE
85	5	1959	25	3	SE
70	5	1959	25	3	NW
8	6	1959	16	3	NE
21	6	1959	28	4	NE
25	7	1959	12	4	NE
67	7	1959	14	4	NE
9	7	1959	23	3	E
20	9	1959	9	3	SE
82	10	1959	1	3	S
62	10	1959	26	2	SE
119	1	1960	28	3	NE
18	2	1960	2	2	W
42	2	1960	2	3	W
10	2	1960	8	4	W
367	2	1960	9	3	W
10	2	1960	19	3	W
188	3	1960	31	2	W
316	4	1960	12	3	SW
63	4	1960	21	4	S
153	5	1960	19	3	N
10	6	1960	9	3	S
193	2	1961	17	3	W
58	2	1961	22	3	W
322	2	1961	23	3	W
44	2	1961	26	4	NW
272	3	1961	3	3	W
91	4	1961	5	2	S
180	4	1961	7	2	W
175	4	1961	7	3	NW

DUR(MIN)	MO	YEAR	DY	T	DD
243	4	1961	10	3	W
119	4	1961	11	3	NW
544	4	1961	13	3	W
420	4	1961	24	3	W
19	5	1961	3	4	W
735	5	1961	7	3	W
222	5	1961	12	3	SW
585	5	1961	13	3	W
24	5	1961	23	4	E
62	5	1961	24	4	NE
47	6	1961	18	4	SW
275	6	1961	19	4	NE
15	6	1961	20	4	NE
115	6	1961	22	4	N
59	6	1961	24	3	W
55	6	1961	27	4	NE
98	6	1961	28	1	S
23	7	1961	14	4	NW
170	7	1961	18	4	NE
196	9	1961	3	2	NE
25	10	1961	1	4	N
24	10	1961	30	3	S
9	2	1962	20	1	W
262	2	1962	25	3	C
78	3	1962	10	2	SW
105	3	1962	23	3	W
58	4	1962	26	2	W
64	5	1962	16	2	SW
17	6	1962	22	3	S
60	6	1962	24	3	E
60	7	1962	16	4	SE
35	7	1962	21	3	NE
115	8	1962	15	4	NE
10	1	1963	19	3	SW
5	2	1963	27	4	E
379	3	1963	3	3	W
125	3	1963	10	3	W
60	3	1963	15	4	W
234	3	1963	21	3	E
100	4	1963	3	2	E
60	4	1963	15	3	W
180	4	1963	17	3	SW
214	5	1963	5	4	SE
220	5	1963	6	2	SE
134	5	1963	19	4	SE
22	6	1963	8	3	W

TABLE A-1 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD
100	7	1963	16	2	C
95	7	1963	25	4	N
90	10	1963	31	4	NE
50	11	1963	7	3	W
55	2	1964	12	3	W
244	2	1964	20	3	N
239	3	1964	7	3	N
240	3	1964	16	3	SE
240	3	1964	22	3	N
60	3	1964	24	3	W
304	4	1964	1	3	SW
59	4	1964	19	3	W
43	5	1964	2	3	W
61	5	1964	5	3	SW
51	5	1964	5	4	W
403	5	1964	7	3	W
345	5	1964	12	2	SE
88	5	1964	25	4	SE
68	6	1964	4	4	S
478	6	1964	23	2	SE
34	7	1964	8	4	S
170	11	1964	11	3	W
15	11	1964	11	4	W
80	12	1964	24	4	W
300	1	1965	25	2	W
365	2	1965	23	3	W
60	3	1965	16	4	W
45	3	1965	17	4	W
60	4	1965	4	3	W
85	4	1965	7	3	NW
101	4	1965	9	3	NW
370	4	1965	10	3	W
14	5	1965	17	4	S
30	5	1965	30	3	SW
28	5	1965	30	4	NE
52	6	1965	17	4	SE
24	6	1965	23	3	NE
60	11	1965	25	3	SW
60	2	1966	7	3	W
134	3	1966	2	3	NW
346	3	1966	22	3	E
50	4	1966	11	2	W
173	4	1966	11	3	W
186	4	1966	18	3	SW
360	4	1966	19	3	SW
70	4	1966	20	3	NE
35	4	1966	30	4	NE
28	5	1966	19	4	NE
8	5	1966	26	3	NE
60	6	1966	9	3	SE
51	8	1966	9	4	NE
60	8	1966	11	4	N
29	8	1966	17	4	S
120	10	1966	14	2	SE
145	11	1966	1	1	S
183	1	1967	6	2	N
52	1	1967	23	4	S
245	1	1967	25	3	W
60	2	1967	5	4	SE
55	2	1967	7	3	NE
299	2	1967	10	3	S
300	3	1967	29	4	SW
223	4	1967	12	3	W
437	4	1967	13	3	W
133	4	1967	17	4	E
29	5	1967	19	3	NW
26	6	1967	17	4	NW
57	6	1967	17	4	SW
195	7	1967	4	4	NE
28	7	1967	26	1	E
30	8	1967	21	4	S
125	10	1967	29	2	NE
120	1[illegible]	1967	17	1	SW
23	12	1967	17	3	W
120	3	1968	31	3	SE
200	4	1968	2	3	W
122	4	1968	6	3	W
15	5	1968	4	4	NE
70	6	1968	13	4	S
304	6	1968	17	1	E
70	6	1968	19	4	NE
67	9	1968	3	4	W
40	11	1968	1	4	E
33	11	1968	10	2	NE
20	3	1969	22	3	S
135	3	1969	23	3	W
77	4	1969	19	3	NE
26	7	1969	16	3	SE
55	3	1970	16	3	NW

TABLE A-1 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
205	3	1970	27	3	W	20	6	1971	20	3	NW
100	5	1970	14	4	E	120	10	1971	29	3	S
18	5	1970	21	3	SW						
70	10	1970	7	4	NE	60	4	1972	12	4	W
						65	4	1972	13	4	W
180	1	1971	2	3	S	83	5	1972	4	3	S
542	2	1971	3	4	W	105	5	1972	7	4	E
190	2	1971	7	3	N	60	7	1972	12	4	NE
180	2	1971	20	3	W	15	8	1972	17	3	NE
120	2	1971	25	4	W						
360	3	1971	5	3	SW	292	4	1973	7	4	E
120	3	1971	18	2	NW	15	4	1973	18	3	W
360	4	1971	13	4	SE	30	5	1973	30	4	S
184	4	1971	18	3	W	153	12	1973	30	1	W
133	5	1971	4	3	W						

TABLE A-2

WHITE SANDS WEATHER STATION
WHITE SANDS MISSILE RANGE, NEW MEXICO
PERIOD OF RECORD: 1954-1973

DUST STORM
(VISIBILITY < 1KM)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
5	2	1954	15	3	NW	21	6	1959	28	4	NE
9	2	1954	18	4	NW	12	9	1959	9	3	SE
15	3	1954	11	1	W	4	10	1959	1	3	SW
269	3	1954	11	3	W						
301	3	1954	23	3	W	131	2	1960	9	3	NW
101	3	1954	30	3	W	73	5	1960	19	3	N
151	4	1954	16	2	SE	136	4	1961	13	3	W
10	7	1954	7	3	E	53	6	1961	22	4	N
95	7	1954	14	3	E	40	6	1961	24	3	W
24	7	1954	31	3	NE	60	8	1962	15	4	NE
4	8	1954	1	4	NW	17	5	1965	30	3	NE
						8	5	1966	26	3	NE
5	4	1955	3	2	NW	8	8	1966	9	4	NE
22	7	1955	4	4	NE	85	7	1967	4	4	N
77	10	1956	29	2	SW	16	12	1967	17	3	W
61	11	1956	1	3	NW	6	7	1969	16	3	SE
45	4	1958	8	3	W						
5	9	1958	18	4	NE	30	3	1970	16	3	NW
5	5	1959	14	4	SE	65	5	1972	4	3	S

TABLE A-3

HOLLOMAN WEATHER STATION
HOLLOMAN AIR FORCE BASE, NEW MEXICO
PERIOD OF RECORD: 1960-1973

BLOWING DUST
(VISIBILITY < 11KM)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
118	1	1960	14	2	SW	111	3	1961	18	3	SW
129	2	1960	2	3	W	19	3	1961	23	4	S
375	2	1960	9	3	W	79	4	1961	7	3	S
75	2	1960	16	4	W	87	4	1961	7	4	SW
183	2	1960	19	3	SW	154	4	1961	8	2	SW
151	2	1960	22	3	SW	303	4	1961	8	4	NE
348	2	1960	27	3	SW	348	4	1961	10	3	SW
344	2	1960	29	3	S	214	4	1961	11	4	N
98	3	1960	8	3	W	547	4	1961	13	3	SW
45	3	1960	9	3	W	59	4	1961	14	3	SW
39	3	1960	13	4	W	220	4	1961	14	4	N
57	3	1960	16	3	NW	13	4	1961	21	3	SW
53	3	1960	23	4	W	508	4	1961	24	3	SW
464	3	1960	28	4	SW	495	5	1961	7	3	SW
727	3	1960	31	3	SW	582	5	1961	12	4	SW
615	4	1960	12	3	S	431	5	1961	13	3	SW
114	4	1960	17	4	S	44	5	1961	24	3	NW
17	4	1960	21	4	S	16	6	1961	1	3	S
189	5	1960	14	4	SW	24	6	1961	2	3	S
156	5	1960	19	3	N	125	6	1961	14	4	S
315	5	1960	29	2	SE	15	6	1961	15	4	N
85	5	1960	29	3	S	110	6	1961	18	3	E
71	5	1960	29	4	NW	53	6	1961	19	4	NE
11	5	1960	30	3	SE	93	6	1961	22	4	NE
15	6	1960	6	4	W	29	6	1961	24	4	NW
12	6	1960	10	4	NW	145	6	1961	27	4	NW
22	6	1960	11	3	NW	12	7	1961	13	3	S
15	6	1960	23	4	W	15	7	1961	13	4	NE
147	7	1960	1	3	SE	48	7	1961	18	4	N
60	7	1960	13	4	N	59	8	1961	27	3	E
15	7	1960	29	4	N	53	9	1961	3	2	NW
14	9	1960	20	4	N	43	9	1961	6	1	S
209	10	1960	4	1	SE	61	10	1961	30	3	SE
592	11	1960	27	3	SW	58	12	1961	9	3	W
213	2	1961	23	3	SW	43	1	1962	21	3	SW
226	2	1961	26	4	SW	63	2	1962	20	4	SW
553	3	1961	3	3	SW	257	2	1962	25	3	SW

TABLE A-3 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
171	3	1962	7	3	W	30	5	1963	20	1	S
679	3	1962	10	3	SW	34	6	1963	8	3	SW
313	3	1962	23	3	SW	26	7	1963	7	3	E
70	4	1962	6	1	N	13	7	1963	25	3	NW
201	4	1962	7	4	SW	54	10	1963	31	3	NW
58	4	1962	8	4	W	140	11	1963	7	3	W
41	4	1962	9	3	SW	11	11	1963	18	4	SW
9	4	1962	25	3	S	72	12	1963	21	4	SW
134	4	1962	26	2	W	325	12	1963	29	3	NW
28	5	1962	17	4	NW						
41	6	1962	2	3	NW	57	1	1964	7	3	W
14	6	1962	2	4	SE	59	1	1964	7	4	W
77	6	1962	20	3	W	30	1	1964	8	2	N
56	6	1962	25	3	SW	35	1	1964	18	3	SW
36	7	1962	30	4	SE	174	1	1964	23	3	SW
29	8	1962	2	3	SE	134	2	1964	14	3	SW
15	8	1962	4	3	NE	22	2	1964	26	3	NW
38	8	1962	4	3	S	11	3	1964	3	1	SW
73	8	1962	15	4	E	78	3	1964	3	3	SW
28	8	1962	21	4	NW	131	3	1964	6	3	SW
84	8	1962	30	3	SW	348	3	1964	7	3	SW
						159	3	1964	8	3	NW
294	1	1963	10	1	SE	86	3	1964	10	4	W
328	1	1963	10	3	S	210	3	1964	13	3	SW
135	2	1963	27	4	SW	177	3	1964	16	4	E
86	3	1963	1	4	NW	328	3	1964	19	3	W
408	3	1963	3	3	S	321	3	1964	22	3	S
522	3	1963	10	3	SW	513	3	1964	24	3	SW
440	3	1963	11	4	SW	30	3	1964	26	4	SW
58	3	1963	12	3	S	339	4	1964	1	3	SW
758	3	1963	15	4	S	217	4	1964	2	3	SW
47	3	1963	17	4	SW	84	4	1964	19	3	SW
167	3	1963	18	3	SW	242	4	1964	25	4	SW
105	4	1963	1	4	SW	101	5	1964	2	3	W
20	4	1963	2	3	S	332	5	1964	5	4	W
40	4	1963	4	3	SE	568	5	1964	7	3	SW
188	4	1963	15	3	SW	391	5	1964	12	2	E
117	4	1963	16	3	SW	64	5	1964	16	4	SE
225	4	1963	17	3	S	15	5	1964	26	3	W
261	4	1963	18	3	SW	111	6	1964	17	3	SW
149	4	1963	25	4	S	80	7	1964	2	3	W
48	5	1963	5	4	SW	70	7	1964	3	3	E
53	5	1963	15	3	NW	56	8	1964	19	4	SW
15	5	1963	17	4	S	91	8	1964	25	4	SW
15	5	1963	18	3	W	67	8	1964	31	3	S

TABLE A-3 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
49	10	1964	2	3	C	60	2	1966	7	3	S
18	10	1964	4	3	NE	216	2	1966	7	4	S
25	10	1964	11	4	N	60	2	1966	15	3	SW
59	11	1964	3	2	NE	1563	3	1966	2	3	SW
180	11	1964	11	3	SW	180	3	1966	3	3	W
12	11	1964	15	3	SE	380	3	1966	21	4	SW
						195	3	1966	22	2	NW
679	1	1965	25	2	SW	40	3	1966	27	3	S
78	1	1965	31	4	W	311	4	1966	10	4	W
28	2	1965	11	3	W	631	4	1966	11	3	SW
58	2	1965	23	2	SW	68	4	1966	16	3	W
96	2	1965	23	3	SW	26	4	1966	17	3	NW
219	2	1965	27	4	W	360	4	1966	18	4	W
71	2	1965	28	4	N	657	4	1966	19	3	SW
81	3	1965	1	4	SW	135	5	1966	10	4	W
443	3	1965	16	3	W	44	5	1966	19	3	NW
54	3	1965	23	3	SW	72	6	1966	14	3	SE
120	3	1965	24	3	SW	16	7	1966	6	4	NW
196	3	1965	25	3	W	53	8	1966	7	3	N
54	4	1965	4	3	SW	40	8	1966	9	4	N
67	4	1965	9	3	SW	17	8	1966	11	4	N
420	4	1965	10	3	SW	23	8	1966	31	3	W
43	4	1965	18	4	W	20	9	1966	14	3	NW
88	4	1965	26	3	W	53	10	1966	14	1	W
97	5	1965	5	1	SW	61	11	1966	1	1	SE
17	5	1965	13	3	SW	9	12	1966	5	3	W
57	5	1965	13	4	W	92	12	1966	7	2	SW
71	5	1965	30	3	NW						
41	6	1965	4	3	NW	181	1	1967	6	1	S
89	6	1965	9	3	W	150	1	1967	25	3	SW
59	6	1965	15	4	S	565	2	1967	5	4	N
54	6	1965	17	3	SE	127	2	1967	11	1	N
38	6	1965	21	3	S	316	2	1967	14	4	SW
47	6	1965	22	3	SE	182	2	1967	15	1	SW
22	7	1965	6	4	N	189	2	1967	16	4	SW
32	8	1965	4	4	NE	210	3	1967	5	3	W
16	8	1965	22	4	N	56	3	1967	22	4	S
16	9	1965	2	3	SE	257	3	1967	29	4	SW
17	9	1965	16	4	S	143	3	1967	30	3	W
36	9	1965	29	2	W	38	4	1967	5	2	SW
17	10	1965	15	3	SW	337	4	1967	12	3	SW
89	11	1965	25	3	W	20	4	1967	13	1	W
						181	4	1967	13	3	SW
46	1	1966	31	2	SW	60	4	1967	22	3	SW
135	1	1966	31	3	W	120	4	1967	24	3	SW

TABLE A-3 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
190	4	1967	25	3	SW	41	12	1968	18	1	W
205	4	1967	29	3	SW	73	12	1968	21	2	W
117	4	1967	30	1	W	111	12	1968	21	3	SW
203	4	1967	30	4	W	60	12	1968	21	4	SW
181	5	1967	10	3	W						
11	5	1967	20	3	SE	445	1	1969	8	3	SW
121	5	1967	25	3	SW	35	1	1969	14	3	W
20	5	1967	30	3	W	237	1	1969	22	3	W
63	6	1967	17	4	W	60	1	1969	26	1	W
12	6	1967	28	4	S	180	1	1969	27	3	W
14	7	1967	4	4	N	60	2	1969	16	3	SW
30	7	1967	10	3	N	188	2	1969	23	1	W
16	8	1967	1	3	E	77	3	1969	1	4	N
29	8	1967	1	4	N	107	3	1969	7	1	W
78	8	1967	10	1	NW	300	3	1969	7	3	W
27	8	1967	15	4	NE	107	3	1969	22	3	S
44	8	1967	19	4	NE	363	3	1969	23	4	W
67	8	1967	21	4	NE	15	4	1969	10	3	SE
35	9	1967	7	4	E	90	4	1969	19	2	N
18	9	1967	10	4	N	184	4	1969	26	3	W
60	10	1967	3	4	NE	30	5	1969	30	3	W
140	10	1967	6	3	W	42	6	1969	3	3	W
79	10	1967	14	4	S	20	6	1969	15	4	S
104	10	1967	29	2	NW	6	6	1969	16	4	SE
145	11	1967	3	1	SE	18	7	1969	5	3	S
242	12	1967	1	3	W	25	7	1969	26	4	NW
						60	8	1969	6	4	NW
60	1	1968	31	4	NW	28	9	1969	4	4	N
194	2	1968	21	4	SW						
7	2	1968	22	1	N	120	1	1970	27	4	N
75	2	1968	27	4	SW	74	1	1970	31	3	W
598	4	1968	2	3	SW	60	2	1970	14	3	W
571	4	1968	6	3	SW	53	3	1970	17	4	SW
203	4	1968	16	3	W	196	3	1970	27	3	W
13	5	1968	3	4	W	360	4	1970	11	3	SW
147	5	1968	6	4	W	260	4	1970	14	3	W
21	6	1968	3	4	W	123	4	1970	17	3	S
58	6	1968	19	4	N	130	4	1970	17	3	W
90	7	1968	18	3	N	60	4	1970	21	3	SW
29	9	1968	6	4	N	271	4	1970	28	3	SW
77	9	1968	14	4	W	150	5	1970	14	4	NE
27	9	1968	29	3	S	420	5	1970	15	2	E
83	11	1968	1	4	N	100	5	1970	21	4	S
172	11	1968	10	2	N	24	6	1970	7	3	SE
120	12	1968	12	1	NW	144	6	1970	13	4	W

TABLE A-3 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
19	6	1970	25	4	E	280	3	1972	26	3	W
14	7	1970	19	4	N	400	3	1972	27	3	W
60	7	1970	30	3	W	17	3	1972	28	3	W
60	8	1970	13	4	NE	152	4	1972	6	3	W
100	9	1970	10	2	S	444	4	1972	12	3	SW
216	10	1970	7	4	SW	667	4	1972	13	3	SW
117	10	1970	10	3	W	258	4	1972	14	3	W
23	11	1970	12	3	W	175	4	1972	18	3	SW
						103	4	1972	20	3	SW
408	1	1971	2	3	SW	353	4	1972	25	4	SW
228	1	1971	3	3	W	122	5	1972	4	3	S
474	2	1971	3	3	SW	64	5	1972	7	3	N
66	2	1971	7	3	N	10	5	1972	14	3	NE
110	2	1971	18	1	W	29	6	1972	14	3	W
390	2	1971	18	3	SW	30	6	1972	16	4	N
30	2	1971	20	3	NW	114	6	1972	20	4	S
37	2	1971	25	3	S	55	6	1972	21	4	NW
153	2	1971	25	4	S	60	6	1972	23	4	SW
241	2	1971	28	3	W	10	7	1972	3	4	SE
83	3	1971	1	4	W	13	7	1972	6	3	W
710	3	1971	5	3	SW	10	7	1972	10	3	E
16	3	1971	13	3	SW	12	7	1972	21	3	NE
112	3	1971	14	1	SW	10	7	1972	28	3	E
532	3	1971	17	4	W	75	8	1972	1	3	NE
230	3	1971	24	4	SW	33	8	1972	15	3	SE
120	4	1971	6	1	SE	15	11	1972	12	3	W
323	4	1971	14	2	C						
12	4	1971	15	3	W	142	1	1973	17	3	W
105	4	1971	18	3	W	41	1	1973	19	4	W
489	5	1971	4	3	SW	142	1	1973	26	3	W
60	5	1971	22	3	SW	239	3	1973	13	3	W
233	7	1971	6	2	SE	37	3	1973	18	4	W
60	7	1971	26	4	N	318	4	1973	7	4	N
31	7	1971	29	4	N	173	4	1973	18	3	W
21	8	1971	10	3	N	342	4	1973	19	2	W
22	9	1971	17	3	W	10	4	1973	24	4	NW
12	9	1971	29	3	S	96	4	1973	30	2	SW
59	10	1971	17	3	S	22	4	1973	30	3	SW
120	10	1971	29	3	SW	267	11	1973	19	3	W
						47	11	1973	23	4	NW
23	1	1972	23	4	SW	60	12	1973	2	3	SW
84	3	1972	14	3	NW	80	12	1973	18	3	W
120	3	1972	25	3	SW						

TABLE A-4

HOLLOMAN WEATHER STATION
HOLLOMAN AIR FORCE BASE, NEW MEXICO
PERIOD OF RECORD: 1960-1973

DUST STORM
(VISIBILITY < 1KM)

DUR(MIN)	MO	YEAR	DY	T	DD
30	2	1960	9	2	W
8	3	1960	16	3	N
35	3	1960	28	3	W
89	3	1960	31	3	W
13	5	1960	14	4	W
47	5	1960	19	3	N
44	7	1960	1	3	SE
21	11	1960	27	2	SW
103	11	1960	27	3	W
50	2	1961	23	3	W
163	3	1961	3	3	SW
103	4	1961	13	3	W
191	5	1961	7	3	SW
16	5	1961	12	3	SW
11	5	1961	24	3	NW
27	6	1961	27	4	NW
83	3	1962	23	3	SW
36	4	1962	26	2	SW
14	8	1962	15	4	NE
67	8	1962	30	3	SW
33	1	1963	10	2	SE
51	2	1963	27	3	SW
136	3	1963	3	3	S
13	4	1963	17	3	S
27	6	1963	8	3	SW
24	11	1963	7	3	W
36	12	1963	29	2	NW
22	1	1964	7	4	W
7	1	1964	18	3	SW
22	3	1964	7	3	SW
31	3	1964	19	4	W
20	3	1964	22	3	SW
36	4	1964	25	4	SW
9	3	1965	16	2	W
36	5	1965	30	3	N
12	6	1965	17	3	SE
21	8	1965	4	4	NE
7	10	1965	15	3	SW
12	[illegible]	1966	2	1	SW
20	3	1966	2	2	SW
175	3	1966	2	3	SW
57	3	1966	21	3	SW
395	4	1966	11	3	W
55	4	1966	16	3	W
128	4	1966	19	3	SW
38	5	1966	19	3	NW
36	8	1966	7	3	N
28	8	1966	9	4	N
29	1	1967	6	1	W
12	2	1967	15	1	W
136	4	1967	12	3	W
51	5	1967	25	3	SW
30	6	1967	17	4	W
8	7	1967	4	4	N
5	8	1967	19	4	NE
91	10	1967	29	2	NW
15	12	1967	1	3	W
18	2	1968	21	4	SW
114	4	1968	2	3	W
244	4	1968	6	3	W
5	5	1968	3	4	N
16	6	1968	19	4	N
30	1	1969	8	3	W
17	3	1969	23	3	W
49	4	1969	26	4	N

TABLE A-4 (con.)

DUR(MIN)	MO	YEAR	DY	T	DD	DUR(MIN)	MO	YEAR	DY	T	DD
5	3	1970	27	3	W	5	3	1972	25	3	SW
32	4	1970	17	3	W	51	3	1972	26	2	W
19	5	1970	21	3	SE	73	4	1972	25	4	SW
37	10	1970	7	4	N	30	5	1972	4	3	S
						32	5	1972	7	3	N
153	2	1971	3	3	SW	8	8	1972	15	3	SE
172	3	1971	5	3	SW						
73	3	1971	17	4	W	18	4	1973	7	3	W
						56	4	1973	18	3	W
78	3	1972	14	3	W	7	11	1973	23	4	NW

APPENDIX B

Published data on the occurrence, propagation effects (electromagnetic and acoustic), and properties of atmospheric dust over WSMR are widely dispersed in technical reports and in the open literature. This appendix has been assembled as a guide to the identification of these information sources and to illuminate to a certain degree the gaps in our knowledge of these particulates and their effects.

A given set of data may appear in a technical report, in a journal article, or in both mediums. Thus, there is a certain degree of redundancy embedded in the references. This could be averted by selective filtration of the references; however, for the sake of completeness, all references are included.

The references are summarized in Table B-1. This table is, for the most part, self-explanatory. A dashed line signifies the absence of published data. The properties have been subdivided into three size ranges termed Aitken, large, and giant. In general, no unpublished data are included and no attempt has been made to isolate "in press" or ongoing research.

Each reference is annotated with the author's abstract (if available) together with supplementary information on instrumentation, sampling, and analysis selected to provide a concise overview. For more detailed information, the interested reader is referred to the original report and/or article.

As an additional aid in summarizing published data on atmospheric dust over the WSMR area Fig. B-1 and Table B-2 have been included. Figure B-1 shows the locations of the sampling sites referred to throughout the report. Table B-2 provides additional location information and cites references to published particulate data for an area or for a specific site.

TABLE B-1
ATMOSPHERIC DUST OVER THE WHITE SANDS MISSILE RANGE, NEW MEXICO AREA

ELEMENT	REFERENCE		
Occurrence			
Maximum and mean number of days per month	B-17-19		
Maximum and mean duration in hours by month	B-17-19		
Diurnal variation of relative frequency distribution by month	B-17-19		
Frequency of occurrence of various durations	This report		
Mixing depth	--		
Propagation effects			
Electromagnetic extinction coefficients			
Turbidity and/or particulate component of turbidity	B-3		
Vertical profiles	B-4-7		
Surface	B-2,21-22		
Acoustic attenuation and dispersion	B-8-9		
Properties	Aitken (r<0.1 μm)	Large (0.1 μm<r<1 μm)	Giant (r>1 μm)
Composition	--	B-12, 14, 28-31	B-1, 10-15, 27-30
Refractive index	--	B-23-24	B-23-24
Number concentration	B-3, 14	B-28-31	B-16, 28-31
Size distribution	--	B-3, 25-26	B-3, 20
Mass concentration	--	--	--
Electrical	--	--	--

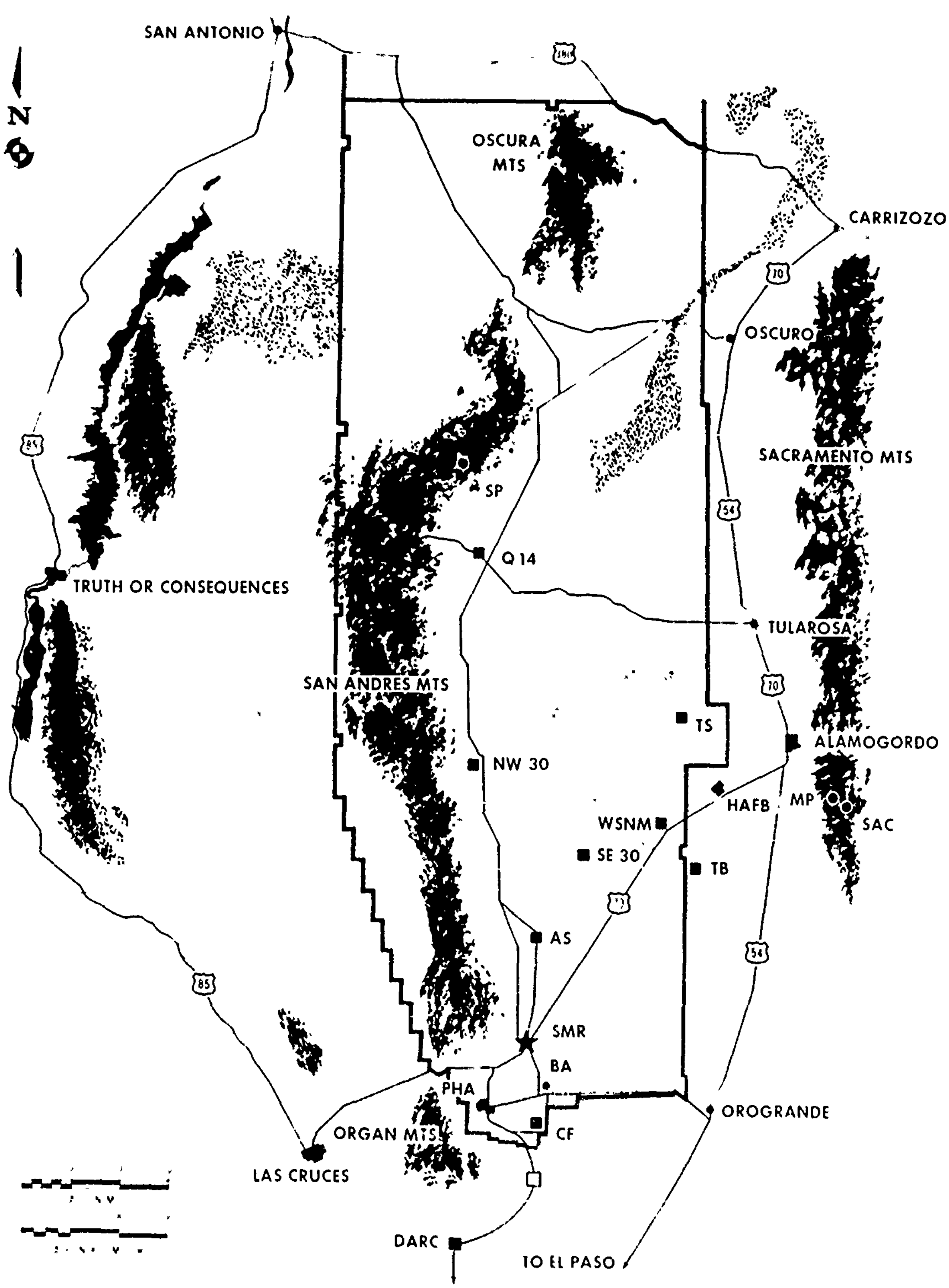


Figure B-1. Map showing locations of sampling sites in the WSMR area referred to in the text. Key to abbreviations is contained in Table B-2.

TABLE B-2

DUST DATA SITE COVERAGE, WHITE SANDS MISSILE RANGE, NEW MEXICO AREA

(Latitude, Longitude, Elevation)

LOCATION	ABBREVIATION	DATA REFERENCES
<u>Basin Floor</u>		
Apache Site (SR Van, Van, Bldg 30880) (32°38;N, 106°24'W, 1206m)	AS	B-(20)
Blockhouse Area	BA	
Desert Site = R Station (32°24'N, 106°22'W, 1216m)		B-(20)
Met Tower (Bldg 20854) (32°24'N, 106°23'W, 1216m)		B-(20,29,31)
LC 36 (32°25'N, 106°19'W, 1383m)		B-2
Condron Field (32°21'N, 106°25'W, 1229m)	CF	B-(20)
Dona Ana Range Camp (32°09'N, 106°30'W, 1300m)	DARC	B-(20)
Holloman Air Force Base	HAFB	
Holloman Weather Central (32°51'N, 106°05'W, 1247m)		B-(25,26)
Northwest 30 (32°53'N, 106°30'W, 1225m)	NW 30	B-(20)
Post Headquarters Area	PHA	
White Sands Weather Central = A Station = Bldg 1510 (32°23'N, 106°29'W, 1296m)		B-17,18,19,27)
Navy = A ≠ A Station (32°23'N, 106°29'W, 1311m)		B-(1,10,11,13,21, 23,24)
Queen 14 (33°05'N, 106°11'W, 1235m)	Q14	B-(20)
Small Missile Range (Bldg 27200) (32°28'N, 106°25'W, 1232m)	SMR	B-(20)

TABLE B-2 (con.)

LOCATION	ABBREVIATION	DATA REFERENCES
Southeast 30 (32°40'N, 106°20'W, 1220m)	SE 30	B-(1,13,21,22)
Tula Site (33°02'N, 106°08'W, 1259m)	TS	B-(20)
Two Buttes = Twin Buttes (32°42'N, 106°08'W, 1388m)	TB	B-(3)
War Road = Highway #1 - to El Paso)		B-(20)
White Sands National Monument Headquarters Area (32°47'N, 106°09'W, 1219m)	WSNM	B-(20)
Mountains		
Sacramento		B-(3)
Mule Peak (32°49'N, 105°53'W, 2472m)	MP	B-(1,12,13,14,15,16), (21,22,28,30)
Sacramento Peak (32°47'N, 105°49'W, 2822m)	SAC	B-(4,5,6,7)
San Andres		
Salinas Peak (33°18'N, 106°32'W, 2730m)	SP	B-(1,13,21,22)

B-1. Blanco, A. J., and G. B. Hoidale, 1968, "Infrared Absorption Spectra of Atmospheric Dust," ECOM-5193, Atmospheric Sciences Laboratory, US Army Electronics Command, White Sands Missile Range, NM, 45 pp. (AD 836 883)

ABSTRACT

Based on the microspectrophotometric analysis of 287 atmospheric dust samples taken within the surface boundary layer over White Sands Missile Range, New Mexico, from May 1966 through October 1967, a representative infrared absorption spectrum spanning the wavenumber range from 4000 to 250 cm^{-1} is presented. The strongest absorption band is centered at 1027 cm^{-1}, within the 1250 to 770 cm^{-1} atmospheric window, and is silicate-induced. Two other strong broad absorption bands are the carbonate band at 1425 cm^{-1} and the silicate band at 468 cm^{-1}. Temporal variations in the absorption spectra of the dust are observed primarily in the varying relative intensities of the 1027 and 1425 cm^{-1} absorption bands and in the occasional enhancement of the 1027 cm^{-1} band caused by sulfates in the dust. This study indicates a close similarity between the absorption spectra of the atmospheric dust and the absorption spectra of the small particle fraction of area soils, and between the representative dust spectrum and a spectrum of a synthetic mixture (by weight) of 80% silicates, 16% carbonates, and 4% nitrates.

LABORATORY ANALYSIS

Sampling Sites

1. eastern slope of Organ Mountains
2. Mule Peak
3. Salinas Peak
4. Southeast 30

Sampling

Membrane filters, 3.5 m above ground

Sampling Periods

Site 1	Site 2
May 1966 to October 1967 (265 samples)	1-23 July 1967 (8 samples)

Site 3	Site 4
26 June to 6 July 1967 (6 samples)	17-28 July 1967 (8 samples)

(16- to 18-hour samples ≈ sunset to sunrise)

Analysis Technique

Infrared Absorption Spectroscopy

B-2. Blanco, A. J., E. M. D'Arcy, and J. B. Gillespie, 1974, "Degradation of a Helium-Neon Laser Beam by Atmospheric Dust During a Sand Storm," ECOM-5535, Atmospheric Sciences Laboratory, US Army Electronics Command, White Sands Missile Range, NM, 14 pp. (AD 776 909)

ABSTRACT

Simultaneous measurements of scattered laser energy (λ = 5328Å and atmospheric particle concentration within three size ranges were made to determine the distribution of scattered energy as a function of angle and particulate concentration. A high number concentration was provided by a short but intense sand storm which fortuitously passed through the array during the experiment. Single and multiple regression techniques were applied to data taken at the peak of the storm and to that taken after it had subsided. Experimental results were used to derive empirical models in estimating the scattered energy distribution under both high and low back-ground levels of particulate concentrations.

IN SITU MEASUREMENT

Site
LC-36

Instrumentation
Single-particle, light scattering counter (Royco Model 202), 1.5 m above ground
Helium-neon laser (Spectra Physics Model 134), 1.5 m above ground

Sampling Period
20 June 1972, 2000-2300 LST

B-3. Bullrich, K., W. Blättner, T. Conley, R. Eiden, G. Hänel, K. Heger, and W. Nowak, 1968, "Research on Atmospheric Optical Radiation Transmission," Interim Sci. Rep. No. 6, 1 Dec 66 to 30 Nov 67, Contract No. F 61052-67-C-0046, AFCRL-68-0186, Meteorol.-Geophys. Inst., Johan. Gutenberg Univ., Mainz, Germany, 163 pp. (AD 670 210)

ABSTRACT (selected portions)

Measurements of the extinction coefficient as a function of wavelength show a wavelength exponent between 1.3 and 1.8 (see pp 8-9, Figures 28-29). In order to get an insight into the atmospheric aerosol particle size distribution near the ground, the Aitken nuclei and the particles $0.3<r<15\mu$ have been measured, the latter with the help of the Royco device. The number of particles undergoes great variations with time, especially in the range of the large ones. There is no connection with the large particles and the variation of the Aitken nuclei. The decrease of the large particles in the radius interval of 0.4 to 2μ follows the power law $r^{-1.6}$. The interval from 0.06 through 0.44 showed r^{-4}. The radiation measurements for the entire atmosphere have yielded a r^{-4} relationship (see pp. 17a-17c, Figures 42-46).

IN SITU MEASUREMENT

Sites
1. Two Buttes
2. Vehicle trip to Sacramento Mountains

Instrumentation
1. Aitken particle counter (Scholz), Sites 1 and 2
2. Single-particle, light scattering counter (Royco), Site 1

Sampling Periods

Instrument 1	Instrument 2	
1967	1967	Hrs (LST)
30-31 March	7 April	0930-1430
5-9 April	8 April	1132-1232

B-4. Elterman, L., 1966, "An Atlas of Aerosol Attenuation and Extinction Profiles for the Troposphere and Stratosphere," Environ. Res. Pap. No. 241, AFCRL-66-828, US Air Force Cambridge Res. Labs., Bedford, MA., 136 pp. (AD 649 778)

ABSTRACT

Light scattering measurements were carried out to determine the aerosol properties of the atmosphere. First the expression for the aerosol attenuation coefficient is derived, based on the field geometry in conjunction with Rayleigh and aerosol scattering considerations. Then the results derived from the measurements are discussed. The paper concludes with an atlas of 105 profiles for altitudes to about 35 km (the data does not exclude the presence of aerosols with low number density between 35 and 70 km). These profiles consist of aerosol attenuation and extinction coefficients as a function of altitude. Since the coefficients are proportional to aerosol number density, the profiles yield information concerning aerosol stratification. A plot for the computed mean of the 105 vertical profiles is included.

INSTRUMENTATION SITES

Optical Collector
Sacramento Peak

Searchlight
Tularosa Basin, 30 km from Sacramento Peak

PROFILES

Date	Time (LST)	Date	Time (LST	Date	Time (LST)
12 Dec 1963	0103	18 Dec 1963	2040	16 Feb 1964	2033
12 Dec 1963	2242	18 Dec 1963	2100	17 Feb 1964	2327
15 Dec 1963	0335	18 Dec 1963	2205	18 Feb 1964	0115
16 Dec 1963	2020	19 Dec 1963	0047	18 Feb 1964	0304
16 Dec 1963	2123	19 Dec 1963	0215	14 Mar 1964	0120
16 Dec 1963	2217	19 Dec 1963	0303	14 Mar 1964	0200
17 Dec 1963	0007	19 Dec 1963	0425	14 Mar 1964	2045
17 Dec 1963	0200	13 Feb 1964	2130	14 Mar 1964	2225
17 Dec 1963	0256	13 Feb 1964	2330	15 Mar 1964	0235
17 Dec 1963	2142	14 Feb 1964	0056	15 Mar 1964	0403
17 Dec 1963	2230	14 Feb 1964	0238	8 Apr 1964	2238
17 Dec 1963	2340	14 Feb 1964	0336	8 Apr 1964	2343
18 Dec 1963	0036	14 Feb 1964	2304	9 Apr 1964	0050
18 Dec 1963	0135	16 Feb 1964	0305	9 Apr 1964	0154
18 Dec 1963	0231	16 Feb 1964	0353	9 Apr 1964	0250

B-4 (con.)

Profiles (con.)

Date	Time (LST)	Date	Time (LST)	Date	Time (LST)
10 Apr 1964	2033	16 Apr 1964	0038	6 Jul 1964	0145
11 Apr 1964	0200	16 Apr 1964	0130	6 Jul 1964	0305
11 Apr 1964	0253	16 Apr 1964	0220	6 Jul 1964	2231
12 Apr 1964	2008	8 May 1964	0215	3 Sep 1964	0046
12 Apr 1964	2110	8 May 1964	0305	3 Sep 1964	0138
12 Apr 1964	2214	8 May 1964	2150	2 Oct 1964	2040
13 Apr 1964	0018	9 May 1964	0035	2 Oct 1964	2217
13 Apr 1964	0058	9 May 1964	0205	2 Oct 1964	2347
13 Apr 1964	0219	9 May 1964	2109	3 Oct 1964	0142
13 Apr 1964	0320	9 May 1964	2216	3 Oct 1964	0303
13 Apr 1964	2215	10 May 1964	0308	5 Oct 1964	1945
13 Apr 1964	2315	10 May 1964	2305	4 Nov 1964	0230
14 Apr 1964	0020	8 Jun 1964	2234	4 Nov 1964	0419
14 Apr 1964	0125	9 Jun 1964	0122	5 Nov 1964	2241
14 Apr 1964	0232	9 Jun 1964	0243	6 Nov 1964	0028
14 Apr 1964	0330	9 Jun 1964	2050	10 Dec 1964	2240
14 Apr 1964	2002	9 Jun 1964	2200	12 Dec 1964	0023
14 Apr 1964	2300	11 Jun 1964	0003	12 Dec 1964	0200
15 Apr 1964	2240	11 Jun 1964	2100	12 Dec 1964	0300
15 Apr 1964	2340	11 Jun 1964	2325	12 Dec 1964	0358

UNPUBLISHED PROFILES

In addition to the 105 profiles cited, the following profiles were taken and are available:

Date	Time (LST)	Date	Time (LST)	Date	Time (LST)
2 Jan 1965	2055	27 Jan 1965	0350	4 Apr 1965	0304
26 Jan 1965	2133	28 Jan 1965	1942	29 Apr 1965	2100
26 Jan 1965	2239	31 Jan 1964	0314	29 Apr 1965	2350
27 Jan 1965	0112	3 Apr 1965	2355	30 Apr 1965	0140
27 Jan 1965	0255	4 Apr 1965	0134	4 May 1965	2130

B-5. Elterman, L., 1966, "Aerosol Measurements in the Troposphere and Stratosphere," Appl. Opt., 5, 1769-1776.

ABSTRACT

Light scattering measurements from a searchlight beam were carried out in New Mexico to determine the aerosol properties of the atmosphere. Although data were acquired to an altitude of about 70 km, the results show the aerosol attenuation parameters to be significant to about 35 km. The expression for the aerosol attenuation coefficient is derived based on the field geometry in conjunction with Rayleigh and aerosol scattering considerations. The results are categorized into moderate-structured, medium-structured and full-structured aerosol profiles. Examples of each are discussed and measurements presented which show variation over a 6-hr period. A quantitative examination is made of the 20-km aerosol layer. Also, a medium-structured profile is selected and treated more extensively to provide preliminary information pertaining to atmospheric scattering and transmission. Ultimately, the data accumulated will provide a substantial number of profiles that will form a basis for various atmospheric studies.

INSTRUMENTATION SITES

Optical Collector
Sacramento Peak

Searchlight
Tularosa Basin, 30 km from Sacramento Peak

DATA BASE

Published profiles [B-4]

B-6. Elterman, L., R. Wexler, and D. T. Chang, 1969, "Features of Tropospheric and Stratospheric Dust," Appl. Opt., 8, 893-903.

ABSTRACT

A series of 119 profiles obtained over New Mexico comprises aerosol attenuation coefficients vs altitude to about 35 km. These profiles show the existence of several features. A surface convective dust layer extending up to about 5 km is seasonally dependent. Also, a turbidity maximum exists below the tropospause. The altitude of an aerosol maximum in the lower stratosphere is located just below that of the minimum temperature. The colder the minimum temperature, the greater is the aerosol content of the layer. This relationship suggests that the 20-km dust layer is due to convection in tropical air and advection to higher latitudes. Computed averages of optical thickness show that abatement of stratospheric dust from the Mt. Agung eruption became evident in April 1964. Results based on 79 profiles characterizing volcanic dust abatement indicate that above 26 km the aerosol scale height averages 3.75 km. Extrapolating with this scale height, tabulations are developed for UV, visible, and IR attenuation to 50 km. Optical mixing ratios are used to examine the aerosol concentrations at various altitudes, including a layer at 26 km having an optical thickness 10^{-3} for 0.55-μ wavelength.

INSTRUMENTATION SITES

Optical Collector
Sacramento Peak

Searchlight
Tularosa Basin, 30 km from Sacramento Peak

DATA BASE

Published and unpublished profiles [B-4]

B-7. Elterman, L., R. B. Toolin, and J. D. Essex, 1973, "Stratospheric Aerosol Measurements with Implications for Global Climate," Appl. Opt., 12, 330-337.

ABSTRACT

This paper presents the measurement results obtained in New Mexico with bistatic, optical probing of the atmosphere by a searchlight beam. The data yield vertical profiles of the aerosol attenuation coefficient. Because they approximate proportionality to aerosol concentration, these profiles provide information concerning the aerosol layer structure and its parameters. During a 9-day period in Oct. and Nov. 1970, a series of 41 such profiles was obtained, which includes altitudes 12-25 km, selected for study because of the relatively high aerosol content of this stratospheric region and its relation to global climate. The mean stratospheric aerosol distribution of this period is double-layered, with maxima at 15.6 and 19.3 km. An early phase of volcanic dust incursion is examined. A chronology of stratospheric aerosol concentration levels is developed, based upon measurements with the same instrumentation at the same sites, since Feb. 1963. The chronology shows that the particulate background level of a nonvolcanic, nonpolluted stratosphere is represented by an aerosol optical thickness τ_p $(0.55\mu) = 2.0 \times 10^{-2}$. A calculation with this background level is included, which indicates feasibility of a laser-satellite method for acquiring data related to global climate. The Appendix introduces an original method of numerical integration (used in the calculations), which is suited to radiative transfer studies.

INSTRUMENTATION SITES

Optical Collector
Sacramento Peak

Searchlight
Tularosa Basin, 30 km from Sacramento Peak

DATA BASE

41 profiles (unpublished) obtained during 9-day period, October and November 1970.

B-8. Henley, D. C., and G. B. Hoidale, 1971, "Attenuation and Dispersion of Acoustic Energy by Atmospheric Dust," ECOM-5370, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, NM, 35 pp. (AD 728 103)

ABSTRACT

Insight into the role of atmospheric dust in the attenuation and dispersion of acoustic energy in the lower troposphere is gained by a comparison of theoretical attenuation coefficients and dispersion functions in the 10^0- to 10^7-Hz range for the mechanisms of classical absorption, molecular absorption, turbulent scattering, and dust absorption for three models of atmospheric dust conditions. Over most of this frequency range the attenuation due to dust absorption is masked by one or more of the other attenuating mechanisms, but at the lower frequencies there appear to be physically realizable conditions of high dust concentration and low turbulent scattering wherein dust absorption may become significant. Also, at the lower frequencies the absolute magnitude of the dispersion function due to dust is much greater than that due to classical and molecular absorption.

DATA BASE

Atmospheric dust model based on WSMR particulate data

B-9. Henley, D. C., and G. B. Hoidale, 1973, "Attenuation and Dispersion of Acoutic Energy by Atmospheric Dust," J. Acoust. Soc. Am., 53, 437-445.

ABSTRACT

Insight into the role of atmospheric dust in the attenuation and dispersion of acoustic energy in the lower troposphere is gained by a comparison of theoretical attenuation coefficients and dispersion functions in the 10^0- to 10^7-Hz range for the mechanisms of classical-rotational absorption, molecular absorption, turbulent scattering, and dust absorption for a variety of dust and meteorological conditions. Over most of this frequency range the attenuation due to dust absorption is masked by one or more of the other attenuating mechanisms, but at lower frequencies there appear to be physically realizable dust and meteorological conditions wherein dust absorption may become significant. However, the most significant effect of atmospheric dust upon acoustic energy propagation lies in its dispersion, which is opposite in sign and much larger at lower frequencies than dispersion due to classical and molecular effects. The magnitudes of absorption coefficients and dispersion functions for dust are directly proportional to the particle concentration, and their frequency dependence varies with the particle size distribution.

DATA BASE

Atmospheric dust model based on WSMR particulate data

B-10. Hoidale, G. B., S. M. Smith, A. J. Blanco, and T. L. Barber, 1967, "A Study of Atmospheric Dust," ECOM-5067, Atmospheric Sciences Laboratory, US Army Electronics Command, White Sands Missile Range, NM, 132 pp. (AD 654 990)

ABSTRACT

This report discusses the techniques used in and the results of an investigation of the mineral constituency of the dust component of the atmospheric aerosol over White Sands Missile Range, New Mexico, conducted from November 1964 to August 1965. The eighty-one atmospheric dust samples, taken near the surface during this period, were analyzed by the light microscope technique of dispersion-staining and by infrared absorption spectroscopy. Dispersion staining was used to determine the concentrations of quartz, kaolinite, illite, gypsum, and the carbonate family when the particle diameters were greater than four microns. Cases of exceptionally high concentrations of gypsum, quartz, and kaolinite, the month-by-month variation of the composite concentration, the seasonal variation of the gypsum concentration, and the lowest single-sample composite concentration are discussed in relation to the mineral content of area soils and meteorological conditions. Comments are made relative to the possible influence of extraterrestrial and sea-salt particles on the observed concentrations. By extending infrared absorption spectra to 40 microns wavelength, it has been possible to identify the minerals gypsum, mirabilite, quartz, kaolinite, illite, calcite, and dolomite in microgram samples of atmospheric dust, although any particular sample might reveal only a few of these constituents.

LABORATORY ANALYSIS

Sampling Site
Eastern slope of Organ Mountains

Sampling
Membrane filters, 3.5 m above ground

Sampling Period
November 1964 to August 1965
(81 16- to 18-hour samples)

Analysis Techniques
Dispersion Staining Microscopy
Infrared Absorption Spectroscopy

B-11. Hoidale, G. B., and S. M. Smith, 1968, "Analysis of the Giant Particle Component of the Atmosphere Over an Interior Desert Basin," Tellus, 20, 251-268.

ABSTRACT

An investigation of the mineral constituency of the dust component of the atmospheric aerosol over southcentral New Mexico was conducted from November 1964 to August 1965. The 81 atmospheric dust samples, taken near the surface during this period, were analyzed by dispersion-staining microscopy to determine the concentrations of quartz, kaolinite, illite, gypsum, and the carbonate family within the "gaint particle" range. These data reveal that high gypsum concentrations are rare despite proximity to one of the world's largest exposed surface deposits of gypsum, that kaolinite and illite concentrations rise with cold frontal passage from the east if the suspected source region is not snow-covered or water-soaked, and that there exist seasonal variations in concentrations. Geometric mean particle concentrations for the 81 samples were: quartz, eight per cent; kaolinte, eight per cent; illite, five per cent; gypsum, three per cent, and carbonates, ten per cent. Comments are made relative to the possible influence of oceanic and extraterrestrial particles on the observed concentrations.

LABORATORY ANALYSIS

Sampling Site
Eastern slope of Organ Mountains

Sampling
Membrane filters, 3.5 m above ground

Sampling Period
November 1964 to August 1965
(81 16- to 18-hour samples)

Analysis Technique
Infrared Absorption Spectroscopy

B-12. Hoidale, G. B., and A. J. Blanco, 1968, "An Infrared Spectroscopic View of the Nature of Giant and Large Particle Atmospheric Dust," J. Rech. Atmos., III, 2e, No. 4, 293-299.

ABSTRACT

Microspectrophotometric analysis of impactor samples of atmospheric dust collected adjacent to an interior desert basin reveal a transition from a silicate clay and carbonate-dominated giant particle to an ammonium sulfate-dominated large particle fraction.

LABORATORY ANALYSIS

Sampling Site
Mule Peak

Sampling
Multi-stage impactor (Andersen Model 705), 9 m above ground

Sampling Peirods

1968	Hrs (LST)
24-25 April	0800-0800
25-26 April	0800-0800
1-2 May	1800-1800
2-3 May	1800-1730
16-17 May	0600-0600
17-18 May	0600-1200

Analysis Technique
Infrared Absorption Spectroscopy

B-13. Hoidale, G. B., and A. J. Blanco, 1969, "Infrared Absorption Spectra of Atmospheric Dust Over an Interior Basin," Pure Appl. Geophys., 74, 151-164.

ABSTRACT

Based on the qualitative microspectrophotometric analysis of 287 atmospheric dust samples taken within the surface boundary layer over south-central New Mexico from May 1966 through October 1967, a representative infrared absorption spectrum from 4000 to 250 cm^{-1} (2.5 to 40 μm) is presented. The strongest absorption band is centered at 1027 cm^{-1} (9.7 μm), within the 1250 to 770 cm^{-1} (8 to 13 μm) atmospheric window, and is silicate-induced. Two other strong broad absorption bands are the carbonate band at 1425 cm^{-1} (7.0 μm) and the silicate band at 468 cm^{-1} (21.4 μm). Temporal variations in the absorption spectra of the dust are observed primarily in the varying relative intensities of the 1027 and 1425 cm^{-1} (9.7 and 7.0 μm) absorption bands and in the occasional enhancement of the 1027 cm^{-1} (9.7 μm) band caused by sulfates in the dust. This study indicates that there is a close similarity between the absorption spectra of the atmospheric dust and the spectra of the small particle fraction of area soils, and between the representative dust spectrum and a spectrum of a synthetic mixture (by weight) of 80% silicates, 16% carbonates, and 4% nitrates.

LABORATORY ANALYSIS

Sampling Sites
1. eastern slope of Organ Mountains
2. Mule Peak
3. Salinas Peak
4. Southeast 30

Sampling
   Membrane filters, 3.5 m above ground

Sampling Periods

Site 1	Site 2
May 1966 to October 1967 (265 samples)	1-23 July 1967 (8 samples)

Site 3	Site 4
26 June to 6 July 1967 (6 samples)	17-18 July 1967 (8 samples)

(16- to 18-hour samples ≈ sunset to sunrise)

Analysis Technique
   Infrared Absorption Spectroscopy

B-14. Hoidale, G. B., A. J. Blanco, N. L. Johnson, and R. V. Doorey, 1969, "Variations in the Absorption Spectra of Atmospheric Dust," ECOM-5274, Atmospheric Sciences Laboratory, US Army Electronics Command, White Sands Missile Range, NM, 31 pp. (AD 697 108)

ABSTRACT

Six impactor and 99 membrane filter samples of atmospheric dust were collected atop a mountain in southcentral New Mexico during April and May 1968. Qualitative analysis of these samples by infrared absorption spectroscopy in the 4000 to 250 cm^{-1} wavenumber (2.5 to 40 μ wavelength) range revealed that the positions and relative intensities of the absorption bands were dependent on the size fraction of the dust and on the time the sample was taken. Within the 1250 to 770 cm^{-1} (8 to 13 μ) atmospheric window, the micron-sized (giant) particles exhibited a peak absorption at 1027 cm^{-1} (9.7 μ), whereas the submicron (large) particles had their peak absorption at 1108 cm^{-1} (9.0 μ). These two absorption bands are induced, respectively, by silicate clays and ammonium sulfate. A temporal variation was observed in the ratio of the intensities of 1027 cm^{-1} (9.7 μ) silicate and the 1425 cm^{-1} (7.0 μ) carbonate absorption bands of the giant particles. This ratio was high during the early morning, at times of convective activity and precipitation, and at times of cold frontal passage from the east; it was low during the afternoon and at times of convective inactivity and no precipitation. The low ratio dust is attributed to advection of fresh soil particles from the exchange layer over the adjacent basin and mountains and the high ratio dust to advection of fresh soil particles from the Great Plains and aged soil particles from the overlying free atmosphere.

IN SITU MEASUREMENT

Site
Mule Peak

Instrumentation
Aitken particle counter (General Electric Condensation Nuclei Counter, Cat. No. 112L428G1 w/automatic ranging), 1 m above ground

Sampling Periods
1968
27-28 April
30 April
2 May
4-7 May

LABORATORY ANALYSIS

Sampling Site
Mule Peak

B-14 (con.)

Sampling

1. Multi-stage impactor (Andersen Model 705), 9 m above ground
2. Membrane filters, 3.5 m above ground

Sampling Periods

Impactor

1968	Hrs (LST)
24-25 April	0800-0800
25-26 April	0800-0800
1-2 May	1800-1800
2-3 May	1800-1730
16-17 May	0600-0600
17-18 May	0600-1200

Membrane Filter

1968	Hrs (LST)
23 April	0000-0600
to 19 May	0600-1200
	1200-1800
	1800-2400

Analysis Technique

Infrared Absorption Spectroscopy

B-15. Hoidale, G. B., and A. J. Blanco, 1970, "Temporal Variations in the Nature of Atmospheric Dust Above an Interior Desert Basin," Arch. Meteorol. Geophys. Bioklimatol., 19A, 71-88.

ABSTRACT

Qualitative infrared microspectrophotometric analysis of 99 six-hour samples of atmospheric dust collected during April and May 1968 at a mountain laboratory in southcentral New Mexico revealed a systematic, meteorologically interpretable, temporal variation in the mineral constituency of the dust. The ratio of silicated clays to carbonates was high during the early morning, at times of convective activity and precipitation, and at times of cold frontal passage from the east; it was low during the afternoon and at times of convective inactivity and no precipitation. The low ratio dust is attributed to advection of fresh continental particles from the exchange layer over the adjacent basin and mountains and the high ratio dust to advection of fresh continental particles from the western Great Plans and aged continental particles from the free atmosphere.

LABORATORY ANALYSIS

Sampling Site
Mule Peak

Sampling
Membrane filters, 3.5 m above ground

Sampling Period
April to May 1968
Hrs (LST)
0000-0600
0600-1200
1200-1800
1800-2400
(99 samples)

Analysis Technique
Infrared Absorption Spectroscopy

B-16. Hoidale, G., and N. Johnson, 1971, "Variations in Giant Particle Concentrations Near an Interior Desert Basin," Z. Meteorol., 22, 372-376.

ABSTRACT

Number concentrations of giant particles were continuously monitored at a site located about 1300 meters above the eastern edge of the Tularosa Basin of southcentral New Mexico over a two-week period in late March 1969. The background concentration of 0.1 cm^{-3} was associated with particles from the free atmosphere over the desert basin to the west of the sampling site, while the lowest concentrations of 0.01 cm^{-3} were related to snow scavenging and the highest concentrations of 10 cm^{-3} to strong winds near the surface of the basin. The effect of frontal passage was dependent on the magnitude of the prefrontal concentrations and on the history of the influxing air mass.

IN SITU MEASUREMENT

Site
  Mule Peak

Instrumentation
  Single-particle, light-scattering counter (Royco Model 202), 9 m above ground

Sampling Period
  18-30 March 1969, continuous

B-17. Hoidale, M. M., 1964, "Atmospheric Structure White Sands Missile Range, New Mexico. 2: Temperature, Relative Humidity, Dew Point, Station Pressure, Density, Clouds, Hydrometeors, and Lithometeors," ERDA-106, Environmental Sciences Department, U. S. Army Electronics Research and Development Activity, White Sands Missile Range, NM, 116 pp. (AD 429 288)

Site
White Sands Weather Station ("A" Station)

Visibility Criterion
Less than 11 km

Table IX (see p. 101)
Dust, Blowing Dust, Blowing Sand
MEAN NUMBER OF DAYS PER MONTH
(1947-1960)

JAN	2
FEB	2
MAR	5
APR	4
MAY	2
JUN	2
JUL	2
AUG	1
SEP	1
OCT	1
NOV	1
DEC	1

Table X (see p. 102)
Dust, Blowing Dust, Blowing Sand
DURATION IN HOURS
(1947-1960)

	Max	Mean	Min
JAN	18	5	0
FEB	52	12	0
MAR	49	23	0
APR	50	14	0
MAY	19	7	0
JUN	16	4	0
JUL	5	2	0
AUG	2	0	0
SEP	8	1	0
OCT	13	3	0
NOV	24	5	0
DEC	17	5	0

Table XI (see pp. 103-114)
Dust
RELATIVE FREQUENCY DISTRIBUTION BY MONTH(%)
(1947-1960)

JAN	1
FEB	2
MAR	5
APR	3
MAY	1
JUN	1
JUL	0
AUG	0
SEP	0
OCT	0
NOV	1
DEC	1

B-18. Hoidale, M. M., and B. J. Gee, 1971, "Atmospheric Structure White Sands Missile Range, New Mexico. 2: Temperature, Relative Humidity, Dew Point, Station Pressure, Density, Clouds, Hydrometeors, and Lithometeors," DR-590, Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 107 pp. (AD 883 071L)

FOREWORD

This report is a revision of Technical Report ERDA-106 published under the same title in January 1964. The revision updates the original data to cover the period from 1951 through 1969.

Site
White Sands Weather Station ("A" Station)

Visibility Criterion
Less than 11 km

Table IX (see p. 94)
Dust, Blowing Dust, Blowing Sand
NUMBER OF DAYS PER MONTH
(1951-1969)

	Max	Mean	Min
JAN	4	1	0
FEB	7	1	0
MAR	12	3	0
APR	10	3	0
MAY	5	1	0
JUN	7	1	0
JUL	7	1	0
AUG	3	0	0
SEP	5	0	0
OCT	2	1	0
NOV	3	1	0
DEC	6	1	0

Table X (see p. 95)
Dust, Blowing Dust, Blowing Sand
DURATION IN HOURS
(1951-1969)

	Max	Mean	Min
JAN	18	4	0
FEB	65	9	0
MAR	78	14	0
APR	80	17	0
MAY	29	6	0
JUN	26	4	0
JUL	9	2	0
AUG	4	1	0
SEP	8	1	0
OCT	13	2	0
NOV	24	3	0
DEC	20	2	0

B-18 (Con.)

Table XI (see pp. 96-107)

Dust

RELATIVE FREQUENCY DISTRIBUTION BY MONTH (%)

(1951-1969)

JAN	1
FEB	2
MAR	2
APR	3
MAY	1
JUN	1
JUL	0
AUG	0
SEP	0
OCT	0
NOV	1
DEC	0

B-19. Hoidale, M. M., and L. Newman, 1974, "Atmospheric Structure White Sands Missile Range, New Mexico. 2: Temperature, Relative Humidity, Dew Point, Station Pressure, Density, Clouds, Hydrometeors, and Lithometeors," DR-822, Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 115 pp. (AD 779 435)

FOREWORD

This report is a revision of Data Report 590 published under the same title in January 1971. The revision updates the original data to cover the period from 1951 through 1973.

Site
White Sands Weather Station ("A" Station)

Visibility Criterion
Less than 11 km

Table IX (see p. 92)
Dust, Blowing Dust, Blowing Sand
NUMBER OF DAYS PER MONTH
(1951-1973)

	Max	Mean	Min
JAN	4	1	0
FEB	7	1	0
MAR	12	2	0
APR	10	3	0
MAY	5	1	0
JUN	7	1	0
JUL	7	1	0
AUG	3	0	0
SEP	5	0	0
OCT	2	1	0
NOV	3	1	0
DEC	6	1	0

Table X (see p. 93)
Dust, Blowing Dust, Blowing Sand
DURATION IN HOURS
(1951-1973)

	Max	Mean	Min
JAN	18	3	0
FEB	65	9	0
MAR	78	12	0
APR	80	15	0
MAY	29	6	0
JUN	26	4	0
JUL	9	2	0
AUG	4	0	0
SEP	8	1	0
OCT	13	2	0
NOV	24	3	0
DEC	20	2	0

B-19 (con.)

Table XI (see pp. 94-105)
Dust
RELATIVE FREQUENCY DISTRIBUTION BY MONTH (%)
(1951-1973)

JAN	0
FEB	1
MAR	2
APR	2
MAY	1
JUN	1
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

B-20. Layton, I., 1957, "Atmospheric Particle Size Distribution," Tech. Memo. No. 482, Missile Geophysics Division, US Army White Sands Signal Agency, White Sands Proving Ground, NM, 52 pp. (AD 155 418)

ABSTRACT

A group of fifty particle-size distribution curves are presented to depict the types of distribution which were observed in the White Sands Proving Ground area during the period from January through August 1957. The graphs show the usual large numbers of small particles among the dust samples. Distributions are presented for exposures in dust storms, squalls, dust devils and some of the water droplet formations which could be sampled from the surface. (Editor's note: 37 of the 50 size-distribution curves were for dry particles, 13 were for liquid particles.)

LABORATORY ANALYSIS

Sampling Sites
  Various (see below)

Sampling
  Oil-coated microscope slides

Sampling Period
  January to August 1957 (see below)

Analysis Technique
  Light microscopy

SIZE DISTRIBUTION CURVES

DATE 1957	TIME (LST)	LOCATION	REMARKS (V=Visibility in miles)
21 Jan	1630	Desert Road near Dona Ana Range Camp	V=1
21 Mar	1635	Desert Road S of WSPG	V=1
15 May	1400	"NW 30"	V=10
15 May	1500	Between "NW 30" and "Van"	V=10
15 May	1545	Between "SR Van" and "SMR"	Tail end of dust devil
20 May	1400	"R" Station	V=1/2
20 May	1625	Desert Road near gate	V=2
20 May	1640	Desert Road S of Condron Field	V=1/4
21 May	1230	Between "R" Station and Base	V=2
21 May	1900	Highway 70 near WSNM	V=10
21 May	2330	Highway 70 near WSNM	V=20
24 May	0030	Between Van and SMR	V=1/2
24 May	0130	Dona Ana Range Camp	V=10
29 May	1700	Highway 70 near WSNM	V=1
4 Jun	1330	17 miles S of NW 30	Dust devil
18 Jun	0715	Near Condron Field	V=15
21 Jun	1350	6 miles N of SMR	V=10
21 Jun	1355	6 miles N of SMR	V=10
21 Jun	1400	6 miles N of SMR	V=10
21 Jun	1405	SMR gate	V=10
8 Jul	1300	Tula	V=30, cyclonic dust devil
8 Jul	1415	Near WSNM	V=20
10 Jul	1440	3 miles N of SMR	V=30
11 Jul	1700	15 feet above ground at WSPG	V=2
15 Jul	1443	3 miles E of Queen 14 on Salt Rd.	Road dust raised by truck
17 Jul	1430	5 miles N of SR Van	Cyclonic dust devil
17 Jul	1500	SR Van	V=20, near anti-cyclonic dust devil
17 Jul	1511	SR Van	V=20, near cyclonic dust devil
1 Aug	1350	SR Van	V=30, near cyclonic dust devil
1 Aug	1510	SR Van	Cyclonic dust devil

B-20 (con.)

DATE 1957	TIME (LST)	LOCATION	REMARKS (V=Visibility in miles)
5 Aug	1103	3 miles N of SMR	V=30
16 Aug	1410	6 miles N of SMR	Cyclonic dust devil
20 Aug	1530	Highway 70, 3 miles E of WSPG entrance	Cyclonic dust devil
21 Aug	1245	5 miles N of NW 30	Cyclonic dust devil
27 Aug	1510	2 miles N of SMR	Cyclonic dust devil
27 Aug	1515	2 miles N of SMR	Anti-cyclonic dust devil
27 Aug	1518	2 miles N of SMR	Anti-cyclonic dust devil

B-21. Lentz, W. J., J. T. Hall, and G. B. Hoidale, 1972, "Extinction of Electromagnetic Energy in the 8-12 μm Atmospheric Window by Particulate Matter," Paper presented at the Conference on Atmospheric Radiation, 7-9 August, Fort Collins, Colorado, Preprint Volume, 108-113.

ABSTRACT

Extinction of electromagnetic energy in the 8-12 μm window of the earth's tropospheric envelope is generally regarded as being dominated by the wing absorptions of strong lines of certain gaseous constituents. In recent years, however, it has become increasingly evident that the particulate extinction has been underestimated.

Empirical studies involving the "absorption" of energy by atmospheric particulate matter are often accomplished by means of the potassium bromide (KBr) pellet technique. Such studies have shown a peak extinction in the 8-12 μm region for soil-tropospheric dust samples taken all over the world. This universal extinction is attributed to silicate minerals, principally clays.

Examination of the extinction spectra of samples of dust collected over southcentral New Mexico reveal that the giant particles ($r > 1$ μm) causing strong extinction in the 8-12 μm window are also mainly silicates - montmorillonite, illite, kaolinite, and quartz - and give evidence that the extinction due to submicron particles in this window is dominated by ammonium sulfate. By applying Mie theory to this data it is possible to: a) provide estimates of the relative importance of particulate absorption and scattering; b) compare results with data already published on extinction coefficients for particulate and gaseous matter; c) provide estimates of dust concentrations requisite to significant window extinction; and d) comment on the KBr technique as an analysis tool. To further illustrate the effect of atmospheric dust on extinction, the following factors will be illustrated: a) effect of monodisperse particles of various sizes; b) effect of Junge power law size distributions of various slopes; and c) effect of various assumptions concerning the real and imaginary parts of the refractive index.

DATA BASE

[B-1 and B-13]

B-22. Lentz, W. J., and G. B. Hoidale, 1974, "Estimates of the Extinction of Electromagnetic Energy in the 8 to 12 μm Range by Natural Atmospheric Particulate Matter," ECOM-5528, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, NM, 22 pp. (AD 772 960)

ABSTRACT

Extinction coefficients, based on atmospheric dust sampled over southern New Mexico, are tabulated at 0.2-μm intervals from 8.0 to 12.0 μm for mass concentrations of 1000, 100, and 10 μg m^{-3}. At a concentration of 1000 μg m^{-3}, the peak extinction of about 0.1 km^{-1} occurs at 9.6 μm. The method employed utilizes Mie theory to extrapolate the measured extinction of a suspension of dust in potassium bromide to the extinction of the dust suspended in air. Over the Middle East and North Africa it is estimated that concentrations of 1000 μg m^{-3} and greater occur on an average of 50 to 150 days per year.

DATA BASE

[B-1 and B-13]

B-23. Lindberg, J. D., and L. S. Laude, 1973, "A Measurement of the Absorption Coefficient of Atmospheric Dust," ECOM-5525, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, NM, 12 pp. (AD 772 701)

ABSTRACT

A method developed by previous workers for measuring the absorption coefficient of strongly absorbing powdered materials has been applied to samples of atmospheric dust in the 0.3- to 1.1- μm wavelength interval. This work, which is based on the Kubelka-Munk theory of diffuse reflectance, provides an estimate of the optical absorption coefficient. The corresponding imaginary refractive index is calculated from this value. Results are given for several samples of dry atmospheric dust collected in the desert of southern New Mexico. A typical value for the imaginary refractive index was found to be 0.007 at 0.6 μm, with little dependence on wavelength in the spectral range investigated. These results are found to be in good agreement with those obtained by different methods by other workers.

LABORATORY ANALYSIS

Sampling Site
  Eastern slope of Organ Mountains

Sampling
  Membrane filters, 3.5 m above ground

Sampling Period
  June to August 1972
  (3 7- to 10-day samples)

Analysis Technique
  Dillution Method of Diffuse Reflectance Spectroscopy

B-24. Lindberg, J. D., and L. S. Laude, 1974, "Measurement of the Absorption Coefficient of Atmospheric Dust," Appl. Opt., 13, 1923-1927.

ABSTRACT

A method developed by previous workers for measuring the absorption coefficient of strongly absorbing powdered materials has been applied to samples of atmospheric dust in the 0.3- to 1.1-μm wavelength interval. This work, which is based on the Kubelka-Munk theory of diffuse reflectance, provides an estimate of the optical absorption coefficient. The corresponding imaginary refractive index is calculated from this value. Results are given for several samples of dry atmospheric dust collected in the desert in southern New Mexico. A typical value for the imaginary refractive index was found to be 0.007 at 0.6 μm, with little dependence on wavelength in the spectral range investigated. These results are found to be in good agreement with those obtained by different methods by other workers.

LABORATORY ANALYSIS

Sampling Site
Eastern slope of Organ Mountains

Sampling
Membrane filters, 3.5 m above ground

Sampling Period
June to August 1972
(3 7- to 10-day samples)

Analysis Technique
Dillution Method of Diffuse Reflectance Spectroscopy

B-25. Miranda, H. A., Jr., and R. Fenn, 1974 "Stratospheric Aerosol Sizes," Geophys. Res. Letters, 1, 201-203.

ABSTRACT

A balloon-borne submicron aerosol counter was successfuly flown on three stratospheric balloon experiments over Holloman Air Force Base, New Mexico, in May 1973. The results indicate that particulate matter at altitudes above 23 km has markedly different scattering parameters from particles at lower levels. This effect is manifested in the form of increasingly steeper size distributions and a lack of particles larger than 0.4 μm diameter. The extent to which these features are attributable either to nonspherical particles or to particle index of refraction uncertainties rather than to the actual size distribution, is a matter of conjecture.

BALLOON RELEASES

Holloman AFB
17 May 1973, 0600 LST (2.5 - 13.8 km)
24 May 1973, 0501 LST (2.5 - 26.6 km)
29 May 1973, 0306 LST (16.3 - 27 km)
(only data from 24 May flight presented)

B-26. Miranda, H. A., Jr., J. Dulchinos, and H. P. Miranda, 1973, "Stratospheric Balloon Aerosol Particle Counter Measurements," Final Rep. No. FR 2001-73, 2 Feb 73 to 30 Nov 73, Contract No. F19628-73-C-0138, AFCRL-TR-73-0700, Epsilon Labs., Inc., Bedford, MA, 77 pp. (AD 777 135)

ABSTRACT (selected portion)

A balloon-borne submicron aerosol counter developed under previous Air Force contracts was successfully flown on three stratospheric balloon experiments over Holloman AFB, New Mexico in May 1973. The results indicate that particulate matter at higher levels is characterized by markedly different scattering parameters than is the case at lower levels. This effect is manifested in the form of exceedingly sharp cut-offs in the size distribution at about 0.4 μ diameter, which is only observed above 23 km. The extent to which this sharp cut-off is attributable either to nonspherical particles or to index of refraction uncertainties rather than to the actual size distribution, is a matter of conjecture.

BALLOON RELEASES

Holloman AFB
- 17 May 1973, 0600 LST (2.5 - 13.8 km)
- 24 May 1973, 0501 LST (2.5 - 26.6 km)
- 29 May 1973, 0306 LST (16.3 - 27 km)

B-27. Riedmuller, G. F., and T. L. Barber, 1966, "A Mineral Transition in Atmospheric Dust Transport," ECOM-5072, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, NM, 9 pp. (AD 641 706)

ABSTRACT

The minerals mirabilite and thenardite differ only in number of waters of crystallization, and may easily change from one state to the other. The identification of the minerals in airborne dust by infrared absorption spectroscopy and the rapidity of the transition are discussed.

LABORATORY ANALYSIS

Sampling Site
White Sands Weather Station ("A" Station)

Sampling
Lumps of mirabilite and thenardite in sieves

Sampling Periods
7-8 February 1966
28 February to 1 March 1966

Analysis Technique
Infrared Absorption Spectroscopy

B-28. Rinehart, G. S., 1970, "Sulfates and Other Water Solubles Larger Than 0.15 μ Radius in a Continental Nonurban Atmosphere," ECOM-5336, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, NM, 17 pp. (AD 716 999)

ABSTRACT

Number concentrations of large and giant atmospheric particles and particles containing sulfate and water-soluble constituents during 10 days in March 1969 were determined. Particles were collected by means of an Andersen multistage impactor and examined by means of an optical microscope. The number of particles collected and concentration of sulfate and water-soluble particles at the isolated New Mexico sampling site were comparable to literature-cited values of average continental concentrations over mountains or unpolluted areas. The number concentrations of giant and large particles did not appear to be influenced in the same way by meteorological parameters. Increases in the number of large particles were mirrored by corresponding increases in sulfate content. Data for relating Andersen sampler aerosol number concentrations to concentrations reflected by the Royco 202 light scattering aerosol counter are given.

IN SITU MEASUREMENT

Site
Mule Peak

Instrumentation
Single-particle, light-scattering counter (Royco Model 202), 9 m above ground

Sampling Period
19-22 and 24-29 March 1969
(0200 to 0500 LST)

LABORATORY ANALYSIS

Sampling Site
Mule Peak

Sampling
Multi-stage impactor (Andersen Model 705), 9 m above ground

Sampling Period
19-22 and 24-29 March 1969
(0200 to 0500 LST)

Analysis Technique
Chemical Microscopy

B-29. Rinehart, G. S., 1071, "Evidence for Sulfate as a Major Condensation Nucleus Constituent in Nonurban Fog," ECOM-5366, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, New Mexico, 14 pp. (AD 724 610)

ABSTRACT

To learn more about potential fog condensation nuclei content, 71 Andersen sampler particulate samples from the White Sands Missile Range, New Mexico area were examined. During a portion of the sampling period, from September to December 1969, the Royco light scattering counter was employed simultaneously. Sulfates appeared to account for most of the soluble and thus potential condensation nuclei. Moisture was an important positive influence on the number of these particles; wind speed decreased their number. In general, the number of large and giant particles remained constant throughout the day. Daytime fluctuations were attributed to incursions of foreign air masses or to rain washout. It is concluded that the sulfate ion is sufficiently abundant in this and other nonurban areas to be a dominant constituent in cloud and fog condensation nuclei.

IN SITU MEASUREMENT

Site
Bldg 20854 (near Army Block House)

Instrumentation
Single-particle, light-scattering counter (Royco Model 202)

Sampling Period

September to mid-November 1969 (3 m above ground)	mid-November to December 1969 (1 m above ground)

LABORATORY ANALYSIS

Sampling Site
Bldg 20854 (near Army Block House)

Sampling
Multi-stage impactor (Andersen Model 705)

Sampling Period

September to mid-November 1969 (3 m above ground)	mid-November to December 1969 (1 m above ground)

(71 1-hour samples, each collected near midday)

Analysis Technique
Chemical Microscopy

B-30. Rinehart, G. S., 1971, "Sulfates and Other Water Solubles Larger Than 0.15 μ Radius in a Continental Nonurban Atmosphere," <u>J. Rech. Atmos.</u>, V, No. 2, 57-68.

ABSTRACT

Number concentrations of large and giant atmospheric particles and particles containing sulfate and water-soluble constituents during 10 days in March 1969 were determined. Particles were collected by means of an Andersen multistage impactor and examined by means of an optical microscope. The number of particles collected and concentration of sulfate and water-soluble particles at the isolated New Mexico sampling site were comparable to literature-cited values of average continental concentrations over mountains or unpolluted areas. The number concentrations of giant and large particles did not appear to be influenced in the same way by meteorological parameters. Increases in the number of large particles were mirrored by corresponding increases in sulfate content. Data for relating Andersen sampler aerosol number concentrations to concentrations reflected by the Royco 202 light scattering aerosol counter were given.

IN SITU MEASUREMENT

Site
   Mule Peak

Instrumentation
   Single-particle, light-scattering counter (Royco Model 202), 9 m above ground

Sampling Period
   19-22 and 24-29 March 1969
   (0200 to 0500 LST)

LABORATORY ANALYSIS

Sampling Site
   Mule Peak

Sampling
   Multi-stage impactor (Andersen Model 705), 9 m above ground

Sampling Period
   19-22 and 24-29 March 1969
   (0200 to 0500 LST)

Analysis Technique
   Chemical Microscopy

B-31. Rinehart, G. S., 1973, "Evidence for Aitken Particles as Precursors to Sulfate Cloud Condensation Nuclei," J. Rech. Atmos., VII, No. 3, 153-160.

ABSTRACT

Particles of radii greater than 0.15 μ were collected from September through December 1969 with an Andersen Sampler at White Sands Missile Range, New Mexico. Of the 70 sets of particulate samples examined, more than half of the stage-6 samples (particles approximately 0.15 to 0.5 μ radius) contained a soluble sulfate nuclei number concentration greater than 25%. A previous day's rain or morning fog usually accounted for an increase in the total number of particles captured and their sulfate content. Higher than average relative humidity in the area was a lesser but associated causative factor in increasing particulate number and soluble sulfate particles. Based on the continental abundance of sulfur dioxide as a trace gas and evidence for its daytime conversion to sulfate particles, it is postulated that the sulfate nucleus is potentially present in this and other nonurban areas. The increase in large-sized nuclei and the accompanying increase in soluble sulfate content after moisture events suggest that moisture acts to aid in the conversion of sulfur dioxide to sulfate, and that this process occurs largely on Aitken nuclei. The observed increase in particulate number concentration in proximity to moisture events aids in reconciling fog or cloud drop concentrations and large-giant nuclei concentrations, which are often too low to account for the observed number of droplets.

IN SITU MEASUREMENT

Site
Bldg 20854 (near Army Block House)

Instrumentation
Single-particle, light-scattering counter (Royco Model 202)

Sampling Period

September to mid-November 1969 (3 m above ground)	mid-November to December 1969 (1 m above ground)

B-31 (con.)

LABORATORY ANALYSIS

Sampling Site
Bldg 20854 (near Army Block House)

Sampling
Multi-stage impactor (Andersen Model 705)

Sampling Period

September to mid-November 1969	mid-November to December 1969
(3 m above ground)	(1 m above ground)

Analysis Technique
Chemical Microscopy